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RADIOLOGY

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Howard P. Doub, M.D.
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CONTENTS

THE USE OF DIONOSIL IN BRONCHOGRAPHY. A PRELIMINARY REPORT. <i>Charles M. Nice, Jr., M.D., and Manouchehr Azad, M.D.</i>	1
PULMONARY INTRACAVITARY FUNGUS BALL. <i>Emanuel J. Levin, M.D.</i>	9
AN EVALUATION OF PORTAL VENOGRAPHY PERFORMED BY INTRASPLENIC INJECTION OF CONTRAST MATERIAL (SPLENOGRAPHY). <i>Frederick J. Bonte, M.D., Austin S. Weisberger, M.D., and Carlo Piavello, M.D.</i>	17
UNCOMPLICATED DEXTROVERSION OF THE HEART. <i>Richard A. Welsh, M.D., and Benjamin Felson, M.D.</i>	24
PROTRUSIO ACETABULI IN RHEUMATOID ARTHRITIS. <i>Currier McEwen, M.D., Maxwell H. Poppel, M.D., F.A.C.R., Nathaniel Poker, M.D., and H. G. Jacobson, M.D., F.A.C.R.</i>	33
SCLEROSING OSTEOGENIC SARCOMATOSIS. A RADIOLOGIC ENTITY. <i>John E. Moseley, M.D., and Murray H. Bass, M.D.</i>	41
THE CARE OF THE PATIENT WITH ADVANCED CANCER OF THE BREAST. <i>Simeon T. Cantril, M.D.</i>	46
THE DOSIMETRY OF BETA SOURCES IN TISSUE. THE POINT-SOURCE FUNCTION. <i>Robert Loevinger, Ph.D.</i>	55
EFFECT OF OXYGEN ON THE RADIOSENSITIVITY OF MAMMALIAN CELLS. <i>Alan D. Conger, Ph.D.</i>	63
ABSORPTION IN DIFFERENT TISSUES OF COBALT 60 GAMMA RADIATION AND ROENTGEN RAYS WITH HALF-VALUE LAYERS FROM 1 MM. AL TO 5 MM. CU. <i>Lillian E. Jacobson, M.A., F.A.C.R., and Isabelle Knauer, M.A.</i>	70
BODY-SECTION CHOLANGIOGRAPHY WITH A NEW INTRAVENOUS MEDIUM. <i>A. L. L. Bell, M.D., Lewis L. Immerman, M.D., and Joseph Arcomano, M.D.</i>	84
PNEUMATOSIS CYSTOIDES INTESTINALIS WITH A CASE REPORT. <i>Andrew R. McGee, M.D., Stuart F. Penny, M.D., and Norval L. Williamson, M.D.</i>	88
DEFICIENCY OF INTESTINAL GAS IN INFANTS WITH DIARRHEA. A PRES- ENTATION OF THREE CASES. <i>Alexander R. Margulis, M.D., Frances P. Conklin, M.D., Charles M. Nice, Jr., M.D., and Leo G. Rigler, M.D.</i>	93
A DEVICE FOR MEASURING CIRCUMFERENCES ON ROENTGENOGRAMS. <i>Gerhart S. Schwarz, M.D.</i>	97
WORK IN PROGRESS.	101
EDITORIALS: ARTERIOGRAPHY IN SEGMENTAL ARTERIAL OCCLUSION.	107
REAPING THE HARVEST <i>Sydney F. Thomas, M.D.</i>	108
ANNOUNCEMENTS AND BOOK REVIEWS.	110
RADIOLOGICAL SOCIETIES: SECRETARIES AND MEETING DATES.	117
ABSTRACTS OF CURRENT LITERATURE.	121

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PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

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No. 1

The Use of Dionosil in Bronchography

A Preliminary Report¹

CHARLES M. NICE, Jr., M.D., and MANOUCHEHR AZAD, M.D.

THE SEARCH for ideal agents to be used in contrast roentgenography is a continuous one, and in no field is their need more keenly felt than in bronchography. For that procedure it is highly desirable that the following objectives be met:

(1) The degree of irritation produced by the medium should be of sufficiently low degree that bronchography may be performed with a minimum of effort and with the least possible post-bronchographic complications.

(2) The contrast agent should so outline the bronchial tree and provide such roentgenographic contrast that maximum diagnostic utility is attained.

(3) While the above criteria are probably most important, it is also desirable that the contrast medium be removed or absorbed so that later roentgen diagnostic study of the chest may be of maximum benefit.

In our experience the above criteria have been fulfilled best by N-propyl 3:5-di-iodo-4 pyridone-N-acetate (propyliodone), which is manufactured under the trade name of Dionosil. It is the purpose of the present paper to report the results obtained with this contrast medium in 74 bronchographic examinations in 68 patients.

THE INTRODUCTION OF DIONOSIL

The development of bronchographic contrast media is amply covered in the literature (3-8; 11-13; 16-19; 22, 24, 25; 28-30). The more recently introduced absorbable agents have two disadvantages: they are absorbed within a few minutes and are very irritating. With this in mind, Tomich, Basil, and Davis (27) examined several contrast media and finally chose the normal propyl ester of 3:5-di-iodo-4-pyridone-N-acetic acid (propyliodone, Dionosil brand). They described the chemical structure and properties of the substance, performed studies on toxicity and metabolism of propyliodone in animals, and later carried out metabolic studies in man.

The pulverized crystals of propyliodone can be suspended either in an aqueous medium, with a mixture of sodium carboxymethylcellulose and a suitable wetting agent, or in vegetable oils. The term "aqueous propyliodone (Dionosil)" refers to a 50 per cent w/v suspension in an aqueous medium; "oily propyliodone (Dionosil)" is a 60 per cent w/v suspension in arachis oil.

CLINICAL EXPERIENCE WITH DIONOSIL

Brief reports on the clinical use of Dionosil in bronchography have appeared in England, South Africa, Canada, and the

¹ From the Department of Radiology, University of Minnesota Medical School, Minneapolis, Minn. Accepted for publication in January 1955.

United States. Don (2) reported on 60 patients undergoing bronchography at the University Hospital, London. Not satisfied with the translottic method of injection, he used the transtracheal method (through the cricothyroid membrane) on 40 patients with favorable results. Adler and Fainsinger (1), of Johannesburg, in a series of 25 patients obtained good results with translottic, cricothyroid, and bronchial catheter methods of injection. Rendle-Short (21), of the Welsh National School of Medicine, Cardiff, used Dionosil for bronchography in 15 children. McKay and Brodeur (14) performed 75 bronchograms on 60 patients, using the tracheal catheter method of injection. Norris and Stauffer (20) published a report in this country.

Comments on the use of Dionosil by the authors cited above are remarkably consistent. All agree that the medium produces little irritation in the bronchial tree, but that the oily preparation seems slightly less irritating than the aqueous suspension. Little post-bronchographic effect was noted, but in some patients a pyrexial reaction was observed. Usually this was of mild degree, with a temperature elevation to 100° F. on the day following bronchography.

Uniformly good contrast visualization of the bronchial tree was obtained, and a tendency for the contrast medium to outline the bronchial mucosa was noted, resulting in a double-contrast effect. There was little tendency to flooding of the alveoli and it was consistently observed that the medium had largely disappeared in three or four days.

Observing that Dionosil is not a perfect contrast medium because the lateral bronchogram tends to be rather faint in heavy individuals, McKechnie (15) nevertheless concludes that it is a useful and safe agent in the presence of tuberculosis. In 114 bronchographic examinations in 111 tuberculous subjects he observed clearance of the pulmonary fields within a few days. He stated that major complications were nil but that pyrexia was noted in 67

patients, acute bronchitis in 8 patients, temporary collapse of a lobe in 1 patient, non-specific pneumonitis in 1, and spread of the tuberculous process in 1. In 38 instances the temperature had risen to less than 100° F., and in 29 instances it exceeded 100° F. In only 8 patients did the pyrexial reaction last more than three days. Shaw *et al.* (23) also report favorably on the use of oily Dionosil in outlining diseased bronchial segments in pulmonary tuberculosis.

UNIVERSITY OF MINNESOTA SERIES

The combined experience of the radiologic staffs of the University Hospitals and Ancker Hospital of Saint Paul, Minn., comprises 74 bronchographic studies in 68 patients of all age groups, with both aqueous and oily Dionosil. Almost all patients had a bronchoscopic examination immediately prior to bronchography. Premedication was given one hour preceding bronchoscopy and included Nembutal (90 to 180 mg.) by mouth and morphine sulfate (10 mg.) and atropine sulfate (0.04 mg.) hypodermically. Morphine was not used in elderly patients. Smaller doses of premedication sufficed for children. A solution of 2 to 4 per cent cocaine was used to spray the nasopharynx, after which a few drops of the solution were injected through a laryngeal cannula into the larynx. It is recommended that the total amount of cocaine should not exceed 300 mg. Pontocaine in 2 per cent solution is also an effective agent for local anesthesia.

A soft rubber or plastic catheter is inserted as a final step of the bronchoscopic procedure. The patient is taken immediately to the fluoroscopic room, where the catheter is guided into the main bronchus of the lung to be examined. If examination of the upper lobe is desired, the catheter is maintained at a slightly higher level than for bronchography of the lower lobe.

The patient is first placed in the lateral recumbent position and, as the first few cubic centimeters of contrast medium is

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injected under careful fluoroscopic control, the position is altered to fill the desired lobar and segmental bronchi. It is important that sufficient contrast medium be introduced to fill these segments during fluoroscopy, for even delayed bronchograms, taken twenty or thirty minutes later, may not demonstrate a significantly greater degree of peripheral filling. This is especially true when aqueous Dionosil is used. Although we prefer to perform the examination as quickly as possible, undue haste is not necessary, since it has been found that Dionosil is no more irritating than Lipiodol or Iodochlorol. Aimed spot-films are obtained as indicated during the fluoroscopic procedure and, following fluoroscopy, 14 X 17-inch roentgenograms are made in the posterior-anterior and relevant oblique and lateral projections. Following bronchography, postural drainage is practiced and the patients are observed for twenty-four hours. Persons admitted to the hospital only for bronchoscopy and bronchography are discharged if no unusual event occurs. For purposes of this study, post-bronchographic roentgenograms were made, whenever possible, at twenty-four, forty-eight and seventy-two hours.

RESULTS OF PRESENT SERIES

In our experience, both aqueous and oily Dionosil have proved to be far less irritating than aqueous Diodone (Xumbradil). We have found that Dionosil allows an unhurried performance of a more satisfactory examination, being comparable in this respect to Lipiodol and Iodochlorol.

In all of our patients, contrast filling of the bronchial tree was adequate, as demonstrated in the three views described. There were 3 instances in which diagnostic bronchograms were not obtained because of technical difficulties, but subsequent attempts in these same patients were successful.

The tendency to outline the bronchi, with production of a double-contrast effect, was noted in many bronchograms. Occasionally a small amount of contrast ma-

terial entered the alveoli, but not to the degree observed following the use of Lipiodol and Iodochlorol.

Chest roentgenograms were obtained twenty-four, forty-eight, and seventy-two hours following bronchography in order to estimate the degree of clearance of opaque shadows from pulmonary structures. In patients in whom this was not possible, a roentgenogram was obtained at the earliest possible date. We were unable to obtain a follow-up roentgenogram in 7 cases. From a composite study of the remaining examinations, it was estimated that over 75 per cent of the contrast material had disappeared from the pulmonary fields within twenty-four hours. In forty-eight hours over 90 per cent had disappeared, and in seventy-two hours usually only a trace, or none at all, could be seen.

Diagnostic bronchograms were obtained with both the oily and aqueous suspensions of Dionosil. The oily suspension is perhaps less irritating, but also shows a slightly greater tendency to enter the alveoli, which may be responsible for the slightly slower clearance observed on post-bronchographic roentgenograms. Norris and Stauffer (20) found that the oily medium may require one or two days longer for complete clearance.

ILLUSTRATIVE EXAMPLES

A normal bronchogram is illustrated in Figure 1A. Coating of the bronchi with double-contrast effect is shown in Figure 1B. After twenty-four hours most of the contrast material has disappeared (Fig. 1C).

The granular appearance resulting from retained iodized oil and its effects is illustrated in Figure 2A, a roentgenogram taken three months after visualization of the right bronchial tree with Iodochlorol. The same patient had bronchography on the left with Dionosil, and the small opaque residue twenty-four hours later is shown (Fig. 2B).

One significant advantage of an absorbable contrast agent is that, if a bronchogram

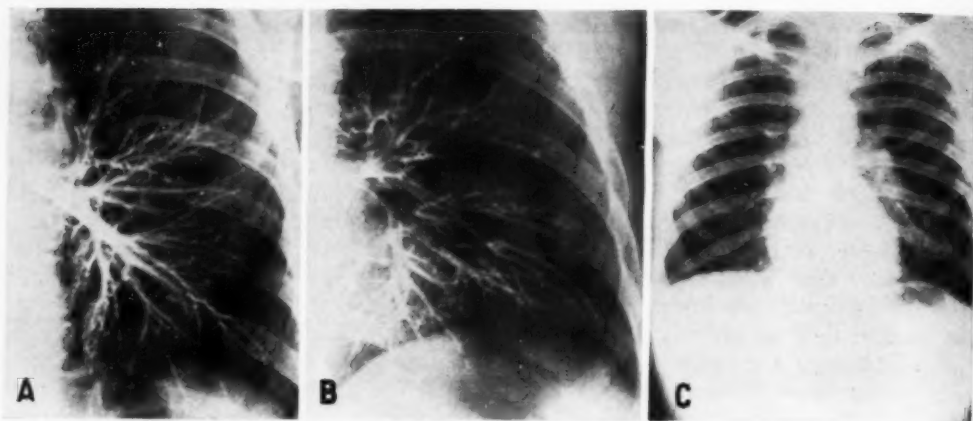


Fig. 1. A. Normal left bronchogram with aqueous Dionosil. B. Close-up view to show double-contrast effect. C. Roentgenogram taken twenty-four hours later to show disappearance of opaque medium.

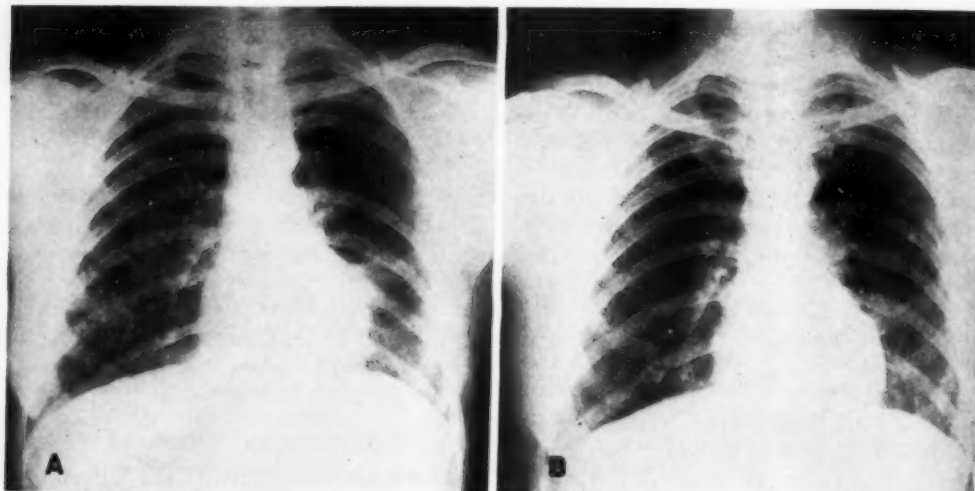


Fig. 2. A. Jan. 28, 1953. Granular appearance of right pulmonary field three months after bronchography with Iodochlorol. The patient has had surgery on the left. B. Jan. 15, 1954. Small opaque residue twenty-four hours after left bronchography with aqueous Dionosil in the same patient.

is unsatisfactory, early re-examination is possible. Figure 3 represents a diagnostic demonstration of a constricted right middle lobe bronchus a day after an unsatisfactory bronchogram.

Figure 4 illustrates bronchiectasis in the left lower lobe; visualization of the right bronchial tree had been interpreted as normal five weeks previously. The absence of contrast agent in the right pulmonary field is noteworthy. Small flecks of contrast material (oily Dionosil) re-

maining one week after the left bronchogram was obtained are shown in Figure 4B.

Figure 5A, the reproduction of an aimed spot-film taken during bronchography with aqueous Dionosil, shows obstruction of the superior segmental bronchus of the left lower lobe. The right oblique view taken ten minutes later demonstrates the "rat-tail" deformity commonly observed in bronchial carcinoma (Figure 5B). Absence of contrast shadow and clear representation of the excavated mass is

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shown in the roentgenogram obtained twenty-four hours later (Fig. 5C). The diagnosis was confirmed by pathologic examination when the left lung was removed surgically.

COMPLICATIONS

We have observed few complications following the use of either aqueous or oily suspensions of Dionosil. A slight cough was noted in about 10 per cent of the patients. In this respect, the oily medium seems slightly less irritating than the aqueous preparation. A temperature elevation, confined to the day following bronchoscopy and usually not exceeding 100° F., occurred in 8 patients. This pyrexial reaction subsided spontaneously without specific medication. In 3 patients slight headache, sore throat, and shortness of breath developed, subsiding the following day. Whether these were due to the procedure as a whole or to the contrast medium is not clear. Two patients had clinical signs of pneumonia following bronchography, but in only 1 was there roentgen evidence of the disease.

DISCUSSION

Previous experience in our institution with absorbable contrast media for bron-

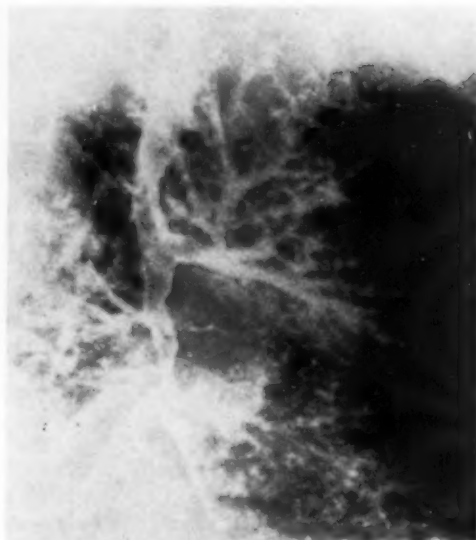


Fig. 3. Aimed spot-film showing constriction of the right middle-lobe bronchus (middle-lobe syndrome). This was obtained during bronchography with Dionosil on the day following an unsatisfactory attempt at bronchography with the same agent.

chography was limited to the use of Xumbradil Viscous B (19). This substance is absorbed rapidly and is, in some respects, superior to iodized oils. From our observations thus far, however, it seems that Dionosil, in either aqueous or oily suspension, is superior to other contrast agents

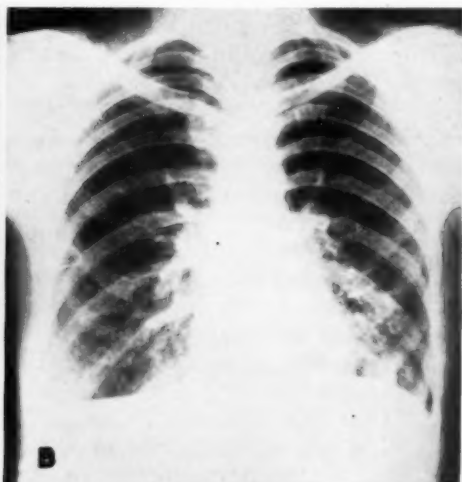


Fig. 4. A. Bronchiectasis of the left lower lobe (oily Dionosil). A bronchogram with Dionosil had been done on the right side five weeks previously. B. Small flecks of opaque medium remaining after one week.

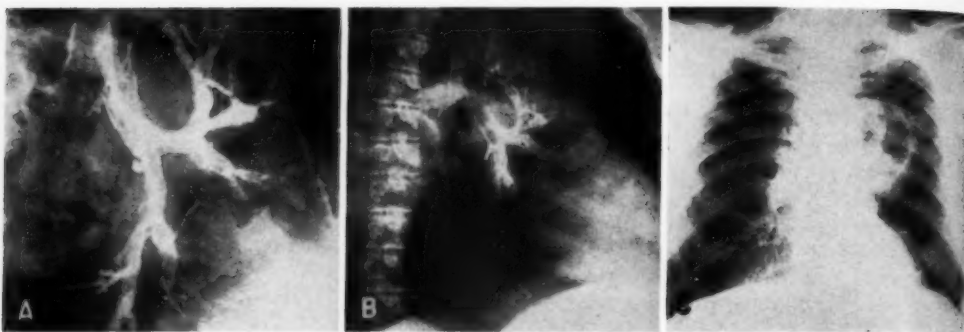


Fig. 5. A. Aimed spot-film obtained during bronchography with aqueous Dionosil, showing obstruction of superior segmental bronchus of the left lower lobe.
B. So-called "rat-tail" deformity of bronchial carcinoma shown on oblique roentgenogram ten minutes later.
C. Control roentgenogram twenty-four hours later, showing absence of contrast substance. Note excavated mass in superior segment of left lower lobe.

used in bronchography. In comparison with the iodized oils, it offers the following advantages

1. Dionosil exhibits less tendency to flood the alveoli.

2. Dionosil is cleared from the pulmonary fields more rapidly, which in turn signifies: (a) that re-examination of the chest by simple roentgen methods is more satisfactory in following patients who have chronic pulmonary disease or who may undergo surgical treatment; (b) that bronchographic examination may be repeated and yield a study of good diagnostic quality at a much earlier date; (c) that the formation of foreign body and granulomatous reactions in the lung is much less likely to occur.

3. The hydrolyzed contrast agent is excreted in the urine without the formation of iodide ions, so that bronchography may be performed in individuals who are sensitive to iodine.

In comparison with other absorbable contrast agents used in bronchography, as exemplified by Xumbradil Viscous B, the following advantages are noted:

1. Dionosil produces less alveolar filling.

2. Dionosil is much less irritating.

3. The rate of absorption of Dionosil is slower, so that an unhurried examination of better diagnostic quality is obtained.

The question arises as to choice between the aqueous and oily suspensions of Dionosil. The oily suspension is less irritating and little anesthesia is required in its use. With careful anesthesia, however, the aqueous suspension is quite satisfactory, although it tends to adhere more strongly to the bronchial mucosa so that it is difficult to fill bronchi beyond the quaternary branches. The oily medium goes well out into the peripheral bronchi and produces much more alveolar filling. This may be a factor in the tendency for the oily form to require slightly longer for absorption.

The manner and completeness of elimination of both the sodium carboxymethylcellulose component of the aqueous medium and the arachis oil of the oily medium are not entirely understood. Vischer (28, 30) cites evidence of granuloma formation following the use of Ioduron B, which contains sodium carboxymethylcellulose as the viscosifying agent.

It appears that either the aqueous or the oily medium might be preferred according to the circumstances under which the bronchographic procedure is performed. When adequate anesthesia of the tracheobronchial tree has been obtained and lesions within the range of the quaternary bronchial branches are being studied, the aqueous medium seems preferable. When relatively light anesthesia has been obtained, or when the supraglottic method of

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instillation is used, as when bronchography is performed as an office procedure, the less irritating nature of the oily medium may be advantageous. In the examination of peripheral lesions such as isolated pulmonary nodules, and in the study of the segmental bronchial changes prior to resectional therapy in pulmonary tuberculosis, the greater peripheral filling produced by the oily medium is of advantage.

With these characteristics in mind, either the aqueous or oily form of Dionosil may be utilized for bronchography, with the expectation of results superior to those obtained with other absorbable contrast agents and the iodized oils. We have encountered no disadvantages in the use of Dionosil that have not been noted following the use of the iodized oils and Xumbradil Viscous B.

SUMMARY AND CONCLUSIONS

1. Experience with the use of Dionosil as a contrast agent in 74 bronchographic examinations in 68 patients is recorded. With both aqueous and oily suspensions of this substance we have encountered no unusual degree of irritability. The examination is unhurried, and bronchograms of good diagnostic quality are easily obtained.

2. There is little tendency for Dionosil to produce extensive alveolar filling.

3. In the majority of patients, only a trace of the opaque substance, propylidone, remains in the pulmonary field three days following bronchography.

4. Many advantages, and no disadvantages, are noted when Dionosil is compared with the iodized oils and Xumbradil Viscous B for bronchography.

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SUMARIO

El Uso del Dionosil en la Broncografía. Informe Preliminar

Relátanse aquí las observaciones de los AA. con el uso del Dionosil como medio de contraste en 74 exámenes bronográficos en 68 enfermos. No se notaron ni mayor irritación ni reacciones graves ni con la suspensión acuosa o la oleosa de esta sustancia. Fué posible obtener broncogramas de buena calidad diagnóstica sin indebida prisa. Obsérvese poca tendencia de parte

del Dionosil a producir extenso henchimiento alveolar, y en la mayoría de los enfermos no quedaban en el campo pulmonar más que indicios de la sustancia opaca (Propiliodón) a los tres días de la broncografía. Cuando se compara el uso del Dionosil con el de los aceites yodados y del Xumbradil Viscoso B, nótanse muchas ventajas y pocas desventajas.



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Pulmonary Intracavitary Fungus Ball¹

EMANUEL J. LEVIN, M.D.

IN THE MAZE OF diseases attributable to or associated with fungous infections, none are more controversial than broncho-pulmonary moniliasis and aspergillosis. Despite numerous discussions of the clinical, pathologic, and mycologic features of these conditions, considerable variance of

data were included, it was evident that the clinical, radiologic, and pathologic features conformed to a characteristic pattern. Four additional cases, 3 of which were proved, are presented here, in the belief that they amplify and supplement knowledge of this disease.

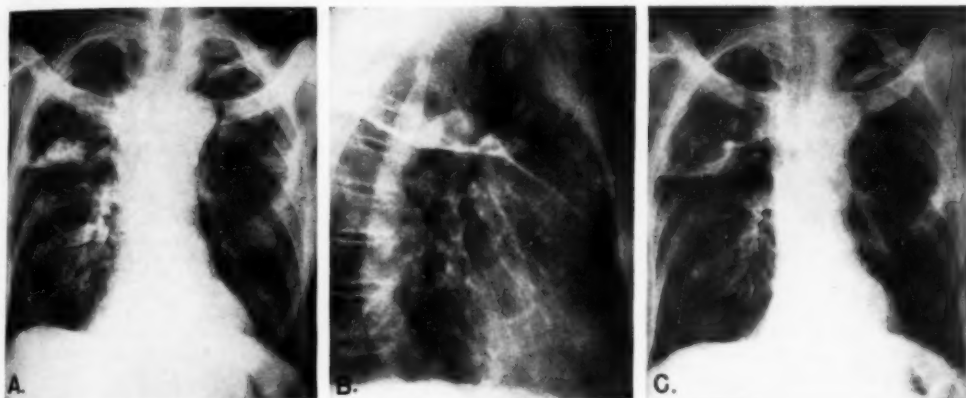


Fig. 1. Case I. A and B. Teleroentgenograms of the chest on admission. A round mass lies transversely in the base of a thin-walled cavity, occupying most of the right upper lobe. C. Three days later. A slight shift in the position of the mass is apparent.

opinion persists concerning criteria for establishing their diagnosis. Even the pathogenicity of *Aspergillus* and *Candida* is subject to dispute. Nevertheless, these fungi in their usual saprophytic state produce a pulmonary lesion with a distinctive radiologic picture, namely, the pulmonary intracavitary fungus ball.

As the designation implies, the essential feature is a ball of mycelia lying free in a pulmonary cavity which communicates with the bronchial tree. According to Monod (7), Dévé described the first case in 1938, and called the process "*megamycetome intrabronchiectasique*." In the ensuing years 23 additional cases have been reported under various appellations, with histologic confirmation in 15 (Table I). In those instances in which sufficient

CASE REPORTS

CASE I: An 82-year-old man was admitted to the Cincinnati General Hospital on July 6, 1952. He appeared chronically ill and dehydrated but complained only of weakness and dyspnea on exertion. The physical examination was normal except for the presence of a Blumer's shelf. The sputum was negative for acid-fast bacilli.

Röntgen Findings: An upper gastrointestinal examination demonstrated a large carcinoma of the stomach. Postero-anterior and lateral teleroentgenograms of the chest (Figs. 1 A and B) showed the right upper lobe to be moderately decreased in volume and almost completely excavated. Lying transversely in the base of the thin-walled cavity was a smooth ovoid mass measuring 3.5×2.5 cm. in diameter. Three days later a repeat examination (Fig. 1C) revealed a slight shift in the position of the mass.

The patient died suddenly on July 15, 1952. At autopsy many dense pleural adhesions were found over the right upper lobe, which was almost com-

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TABLE I: SUMMARY OF THE PERTINENT DATA ON ALL REPORTED CASES OF INTRACAVITARY PULMONARY FUNGUS BALL

Author	Cases	Microscopic Proof	Hemoptyses	Location	Organism	Remarks
Dévé, quoted by Monod <i>et al.</i> (7)	1	1	1	Unstated	<i>A. fumigatus</i>	Patient had clubbed fingers
Metras and Thomas (6)	4	1	2	Right upper lobe, 1 case Left upper lobe, 1 case Unstated, 2 cases	<i>A. fumigatus</i>	No microscopic confirmation of the diagnosis in 3 cases
Hemphill (3)	1	1	0	Right upper lobe	<i>A. fumigatus</i>	A small calcified nodule present in the lower pole of the free body
Gerstl <i>et al.</i> (1)	1	1	1	Left upper lobe	Resembled <i>Aspergillus</i> (sp.)	
Weens and Thompson (11)	2	1	1	Left upper lobe Apex of right lower lobe	Consistent with <i>Actinomyces</i> . Unidentified fungus	One patient had diffuse cystic disease of the lung and the fungus was recovered from the sputum
Yesner and Hurwitz (12)	1	1	1	Apex of left lower lobe	<i>Aspergillus</i> (sp.)	Discovered two years subsequent to pulmonary abscess secondary to dental extraction
Monod <i>et al.</i> (7)	5	5	4	Apex of right lower lobe, 1 case Left upper lobe, 2 cases Unstated, 2 cases	All probably <i>A. fumigatus</i>	One case of 17 years duration. Two patients had basal bronchiectasis
Graves and Millman (2)	1	1	1	Right upper lobe	Resembled both <i>Monilia</i> (sp.) and <i>Aspergillus</i> (sp.)	Discovered during the course of therapy for lung abscess
Shanks and Kerley (10)	3	?	1	Unstated	All <i>Aspergillus</i> (sp.)	One patient had exsanguinating pulmonary hemorrhage. Two patients had clubbing of the fingers. Manner of proof unstated. Abridged report
Hinson <i>et al.</i> (4)	3	3	3	Left upper lobe, 1 case Right upper lobe, 2 cases	All <i>A. fumigatus</i>	One patient had asbestosis
Schinz <i>et al.</i> (9)	1	?	?	Unstated	<i>Aspergillus</i> (sp.)	Manner of proof unstated. Abridged report
Present series	4	3	2	Right upper lobe	Probably <i>Candida</i> (sp.) in all 3 proved cases	
TOTAL	27	18	17			

pletely cavitated. The walls of the cavity were epithelialized and trabeculated. In its dependent portion was a free body, brown in color and soft in consistency, measuring $3 \times 2 \times 2$ cm. Microscopy showed extensive fibrosis and anthracotic pigment along with collections of lymphocytes and plasma cells in the lung adjacent to the cavity, but there was no evidence of fungi, active tuberculosis, or neoplasm. The cavity wall was composed of dense connective tissue containing inflammatory cells.

The loose body consisted of a closely intertwined meshwork of mycelia, apparently representing a single species of fungus. Thick, short, non-septate hyphae showed spores originating from areas of hyphal narrowing. It seemed likely that the fungus

was a species of *Candida*, though it is possible that it belonged to the *Phycomycetes* (sp.). Attempts at culture were unsuccessful.

CASE II (courtesy of Dr. Leonard Gottesman): A 38-year-old male was admitted to the Jewish Hospital, Cincinnati, on Aug. 26, 1952, complaining only of intermittent hemoptysis of six years duration. He dated the onset of his illness to European service in World War II, when he received multiple chest wounds, from which fragments of wood were removed. The hemoptysis was described as ordinarily consisting in no more than blood-tinged sputum, but on occasion as much as a cupful of blood was expectorated and in rare instances this

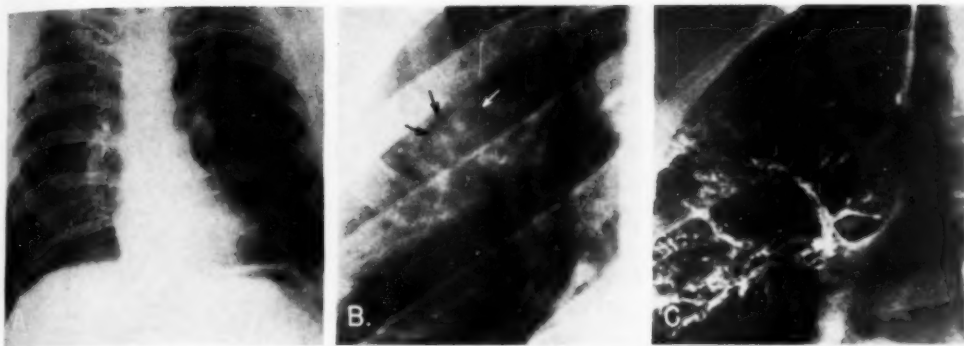


Fig. 2. Case II. A. Telerontgenogram showing a large mass containing calcific nodules (arrow) in the right second interspace. B. Photoenlargement, revealing a thin crescent of air capping the fungus ball, (arrows). C. Bronchogram demonstrating spreading of the normal bronchi around the cavity.

was clotted. Bronchoscopic studies revealed chronic inflammatory changes in the orifice to the right upper lobe bronchus, but no bleeding could be seen. Material aspirated from this area was negative for acid-fast organisms on smear and culture. All other studies were within normal limits.

Rontgen Findings: A mass 4.5 cm. in diameter was present in the posterior segment of the right upper lobe (Fig. 2A). On close inspection (Fig. 2B) this mass was seen to be capped by a thin crescent of air and to contain several small nodules of calcium. Linear fibrotic appearing strands radiated laterally from the apex of the right hilus toward the cavity. Bronchography (Fig. 2C) demonstrated normal bronchi diverging around the lesion. None of the contrast medium entered the cavity.

A wedge resection of the affected area was performed on Sept. 2, 1952. The specimen revealed a thick, dense pleural patch covering an abscess cavity, the wall of which was red-brown in color and irregular in contour. The surrounding lung appeared atelectatic and of a dark red hue. During resection the loose body was macerated.

The microscopic pattern of the intracavitary mass was almost identical with that in Case I, and the fungi were indistinguishable. No growth was obtained on culture.

CASE III (courtesy of Dr. John H. Payne): A 25-year-old male was admitted to the Good Samaritan Hospital, Cincinnati, in May 1953. He had been in excellent health until 1949, when a severe episode of hemoptysis necessitated hospitalization. Since that time repeated bouts of hemoptysis had occurred but only one additional period of hospitalization was required. The patient had no other complaints and there had been no fever or weight loss. All laboratory studies were within normal limits but the sputum was never cultured.

Rontgen Findings: A number of roentgenograms of the chest obtained after July 1950 were available for study. On the initial film (Fig. 3A) a thin-walled cavity, 2 cm. in diameter, was seen in the

posterior segment of the right upper lobe. Within the cavity, and almost entirely separated from its walls by a rim of air, was a mass 1 cm. in diameter. Thin fibrous strands converged toward the apex of the right hilus from the periphery of the lobe.

The cavity slowly increased in size until April 1953 (Fig. 3B), at which time it measured 3 cm. and its contained mass had increased to 2 cm. in diameter. Spot roentgenograms obtained during fluoroscopy established the mobility of the mass. On bronchography a normal bronchial tree was demonstrated, diverging around the lesion. None of the opaque medium entered the cavity.

A right upper lobectomy was performed on May 20. Pathological examination revealed a cavity approximately 1.5 cm. in diameter situated immediately beneath a plaque of thickened pleura. Lying free in the cavity was a large brown friable body resembling a blood clot.

Microscopic examination showed the cavity wall to be thin and fibrous, lined with granulation tissue heavily infiltrated with plasma cells and occasional giant cells. No hyphae were seen in the cavity wall or in the adjacent lung.

The free body consisted of a felting of mycelia identical in appearance with those seen in the previous 2 cases. Cultures of the fungi were sterile.

CASE IV (courtesy of Dr. Leonard Gottesman): A 60-year-old male was told that a photoroentgenogram taken during an industrial survey in 1947 showed disease of the upper lobe of the right lung. Since his only complaint was a mild productive cough he did not consult a physician until he was induced to do so by his family in 1954. Physical signs of a cavity were found in the right upper lobe, but no other abnormality was elicited by clinical or laboratory examination. In particular there was no history of hemoptysis and no acid-fast organisms were present in the sputum. The patient was admitted to the Jewish Hospital for study.

Rontgen Findings: A postero-anterior teleront-

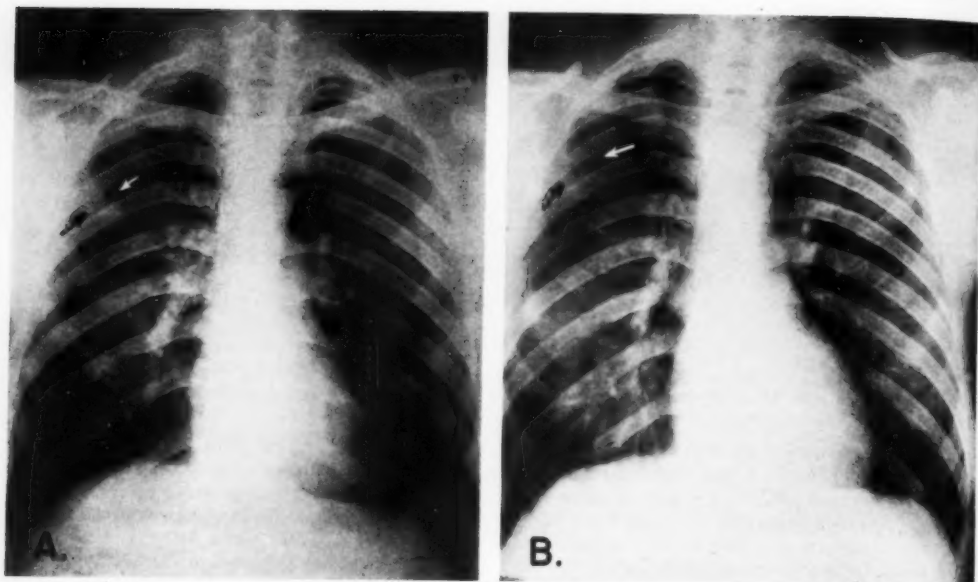


Fig. 3. Case III. A. Teleroentgenogram, August 1950, showing small intracavitary mass in the second right interspace. B. April 1953. There is a slight increase in size of both the cavity and the fungus ball. Note the thin cavity wall.

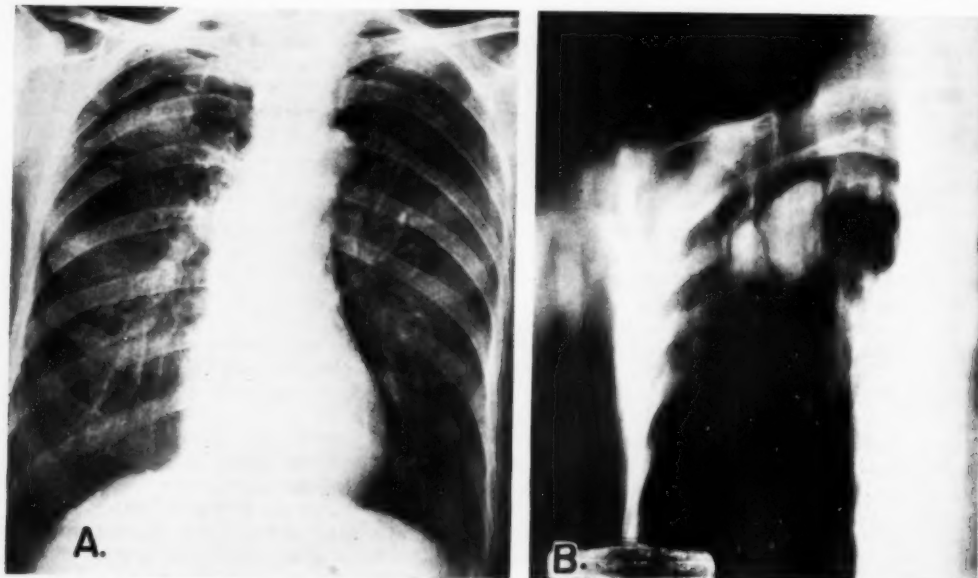


Fig. 4. Case IV. A. Teleroentgenogram showing contracted right upper lobe containing two large masses in a thin-walled cavity. B. Planigram. The calcific rim at the summit of the larger mass and the thin cavity wall and septum are clearly demonstrated.

genogram of the chest, in April 1954 (Fig. 4A), showed a considerable decrease in the size of the right upper lobe, which contained a large thin-walled cavity measuring 4.5×8 cm. In the

dependent portion of the cavity were two large rounded masses, lying side by side, probably separated by a trabecula. The smaller, lateral mass measured 1.5×2.5 cm., the medial mass 2.5×5

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cm. Each was capped by a narrow interrupted plaque of calcium. An increase in the prominence of pulmonary markings was present in the area around the cavity. All these features were demonstrated much more distinctly by planigraphy (Fig. 4B). A diagnosis of pulmonary fungus ball was made.

The patient decided against thoracotomy when advised of the nature of his disease.

CLINICAL DATA

The most characteristic complaint and, in general, the presenting symptom in cases of pulmonary fungus ball was hemoptysis. This occurred in 63 per cent of the collected series of 27 cases (Table I). The pulmonary hemorrhages varied in severity from blood-flecked sputum to exsanguinating episodes of hemoptysis (11), but it was unusual for the bleeding to amount to more than a few tablespoonfuls. As a rule, the bouts of hemorrhage were repeated at intervals of a few months, but in a few instances they were separated by periods of many years.

A second notable feature of the disease was the excellent health enjoyed by almost all of the patients. There were no reports of fever, pain, weight loss, or asthenia. Cough and expectoration were frequently encountered, but rarely were they significant elements of the history.

Laboratory studies were almost invariably normal. Tubercle bacilli were never found in the sputum, and in only 2 instances (2, 11) was a fungus identified. Anemia (10) was the only hematologic abnormality observed, and then only after the occurrence of repeated or severe episodes of hemoptysis.

ROENTGEN FINDINGS

The radiologic diagnosis of an intracavitary fungus ball is readily and reliably made. The fundamental feature is the presence of a rounded mass within a thin-walled cavity.

To date the lesion has been found only in the upper lobes and, rarely, in the superior segment of either lower lobe. The pulmonary parenchyma surrounding the cavity may appear normal or show a decrease in volume, as evidenced by displacement of

the hilus or a fissure. A few fibrotic strands or linear areas of infiltrate are generally seen in the affected segment. The thin-walled cavity is sharply demarcated from the remainder of the lung and lies in apposition to a pleural surface. It is usually circular in outline but may show some degree of scalloping and trabeculation. A fluid level in the cavity has never been reported.

Occupying from 25 to 95 per cent of the total volume of the cavity, and freely movable within its confines, is a smooth, round or ovoid mass. Calcification may be present as small nodules within the mass or as a fine rim around a portion of its periphery. Of paramount importance in the roentgen diagnosis are the mobility of the mass and presence of a crescent of air between it and the cavity wall. These details may not be detected on routine teleroentgenograms, particularly in those cases in which the ball of fungi occupies almost the entire volume of the cavity. If, however, the tangential beam afforded by fluoroscopy with spot-film radiography is utilized in both the upright and recumbent position, the radiolucent crescent as well as the mobile character of the mass will be clearly demonstrated.

One of the more unusual features of this disease is the relative stability of the lesion. No significant change was apparent in a number of patients followed for many years, as long as seventeen years in one case (7). In a few instances, as in our Case III, a slight increase in size of either one or both components of the process was observed.

Bronchograms have not supplied significant additional information. Normal bronchi diverging around the cavity have been visualized, but in only two instances (6) did oil enter the cavity, and in these cases the diagnosis of a cavity had been made prior to bronchography. A similar observation can be made regarding planigraphy, which was utilized in Case IV. It served only to accentuate detail which was well demonstrated by conventional roentgenography.

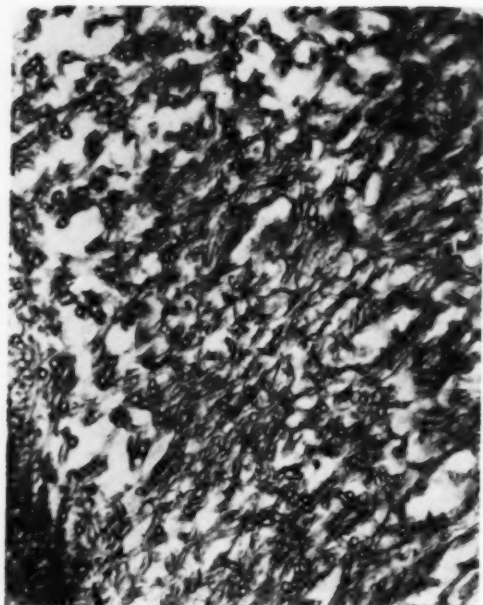


Fig. 5. Photomicrograph demonstrating unsegmented hyphae and spores in the fungus ball. Periodic acid Schiff stain. $\times 450$.

PATHOGENESIS

In almost every case of pulmonary fungus ball reported the responsible organism has been a species of *Aspergillus* or *Candida*. The consensus of mycologists is that these ubiquitous fungi are, as a rule, saprophytic and invade pre-existing pathologic foci only fortuitously. In the condition under discussion they merely represent innocuous invaders of an antecedent cavity. A less plausible theory is presented by the French authors (6, 7), who believe that the fungus is implanted in a normal bronchus, which is gradually dilated by the pressure of the growing colony.

One of the more cogent reasons for the assumption that the fungi under consideration are saprophytic is the invariable presence of hyphae and the absence of yeast forms and spherules in the human host. With rare exceptions (8), true pathogenic fungi do not show hyphae in the host, appearing rather as the yeast form (*Histoplasma* and *Blastomyces*) or as spherules (*Coccidioides*).

The pathologic features of pulmonary

intracavitary fungus ball have been established in 18 cases. The cavity, which, as stated above, has been found only in an upper lobe or in the superior segment of a lower lobe, is indistinguishable from a chronic pulmonary abscess secondary to pneumonia, bronchiectasis, aspiration, or infection of a congenital cyst. It abuts against a visceral pleural surface which is thickened and adherent to the adjacent parietal reflection. Cartilaginous plates, mucous glands, and smooth muscle may be incorporated in the fibrous cavity wall. A membrane composed of varying proportions of granulation tissue and ciliated columnar and metaplastic squamous epithelium lines the capsule. The cavity is usually solitary and unicameral but occasionally contains incomplete septa. Two or three contiguous cavities, each containing a fungus ball, may be present in rare instances, as is presumed to have occurred in Case IV.

Examination of the pulmonary parenchyma in the area adjacent to the cavity shows a minimal amount of chronic pneumonitis, fibrosis, and bronchiectasis, but no fungi are seen even with the use of specific stains.

The free mass lying within the cavity is a smoothly rounded or ovoid friable body, the color of old clotted blood. A dense meshwork of intertwined mycelia constitutes the major component of the mass, but degenerating blood and epithelial elements may be found in the interstices.

A species of *Aspergillus* was reported as the constituent of the fungus ball in 20 cases from the literature. In the 3 proved cases in the present group, *Aspergilli* were not present, as evidenced by the absence of septate hyphae. The hyphae seen were thick, short, and non-septate, apparently with spore formation at areas of hyphal narrowing (Fig. 5). It was felt that, in all probability, the fungus was a species of *Candida*. *Phycomyces* was also a possibility but was considered much less likely, especially in the absence of sporangia.

Mycologic identification of these fungi by cultural methods has for the most part

been unsuccessful, as samples of the fungus ball are usually sterile. The lack of growth on culture in our 3 proved cases may be explained by the presence of non-viable organisms. This is supported by the variation in the staining qualities on microscopic section. With morphologic criteria only, and without knowledge of the cultural characteristics, positive identification of the fungus is, under the best of circumstances, hazardous.

DIFFERENTIAL DIAGNOSIS

The roentgen finding of a smooth, rounded, mobile mass in a thin-walled cavity is believed to be sufficiently distinctive to warrant the diagnosis of an intracavitary fungus ball. Hemoptysis in a healthy person affords evidence supporting this opinion. These characteristics virtually eliminate from consideration such cavitory diseases as acute and chronic pulmonary abscess, necrotic tumors, and liquefied infarcts. Furthermore, it is difficult to conceive of any lesion other than pulmonary hydatid cyst or an inspissated blood clot in an abscess causing serious confusion.

Pulmonary hydatidosis (5) will simulate the appearance of a fungus ball only during its intermediate phase. Initially, it is demonstrable as a solid, round nodule, variable in size, usually in the right lower lobe. Many of these lesions, especially those near the hilus, establish a bronchial communication by spontaneous rupture of the adventitia of the host. Air then dissects under the adventitia and peels away the ectocyst, producing an intracavitary mobile ball. This is, however, a temporary stage, for soon the ectocyst ruptures and the membranes collapse and float on the surface of the cyst fluid, producing the "sign of the camalote."

An inspissated blood clot in an abscess cavity, in contradistinction to a fungus ball, is generally associated with relatively extensive disease in the surrounding parenchyma. It may, however, show all the salient features of the fungus ball and be indistinguishable from the latter.

SUMMARY

The clinical, radiologic, and pathologic aspects of 23 reported cases of pulmonary intracavitary fungus ball have been reviewed and the details of 4 new cases presented. Although the fungus most frequently responsible has been a species of *Aspergillus*, the organism found in our 3 proved cases was probably a species of *Candida*.

Almost all of these patients have been in good health, hemoptysis often being the only clinical abnormality. Roentgen examination reveals the presence of a mobile rounded mass occupying the dependent portion of a thin-walled cavity.

ACKNOWLEDGMENT: We are indebted to Dr. Jan Schwarz for his assistance in unraveling the mycologic aspects of these cases and for his invaluable advice and criticism, and to Dr. Benjamin Felson for assistance in the preparation of the manuscript.

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(Para el sumario en español, véase la página siguiente)

SUMARIO

Bola Intracavitaria Pulmonar de Hongos

Repásanse los aspectos clínico, radiológico e histopatológico de 23 casos comunicados de bola intracavitaria pulmonar de hongos, y se presentan los detalles de 4 casos nuevos. Aunque el hongo causante más frecuente fué una especie de *Aspergillus*, el microorganismo descubierto en los 3 casos comprobados del A. es probablemente una especie de *Candida*.

Casi todos los enfermos disfrutaban de buena salud, siendo a menudo la hemoptisis la única anomalía clínica. El examen roentgenológico revela la presencia de una masa redonda movable que ocupa la porción más baja de una cavidad de paredes delgadas. La presencia de una media luna de aire entre la masa y la pared de la cavidad es indispensable para el diagnóstico.



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An Evaluation of Portal Venography Performed by Intrasplenic Injection of Contrast Material (Splenography)¹

FREDERICK J. BONTE, M.D.,² AUSTIN S. WEISBERGER, M.D.,³ and CARLO PIAVELLO, M.D.⁴

THE CONCEPT OF radiographic visualization of a portal venous system opacified by contrast material injected into the spleen was first developed by Abeatici and Campi in 1951 (1). Since that time a predominantly European body of literature has appeared on this subject (2, 4, 7, 10, 11, 13, 15). Only during the last two years has it begun to make its appearance in American writing (3, 8, 9, 12).

The procedure in question has quite properly been received with a certain amount of circumspection. To determine whether or not it would take its place among standard radiological diagnostic studies appeared to the authors to require careful evaluation. With this in view, they are presenting their experience in 18 cases, with special reference to indications, technics involved, risks incurred, and results obtained.

METHOD

Any patient who has splenomegaly of unknown origin is a candidate for diagnostic splenic puncture, and theoretically any candidate for diagnostic splenic puncture is a candidate for splenography. The term splenography, used by the authors for convenience, is by no means widely accepted, commonly used synonyms being splenic portography, splenoportography, transabdominal splenic portal venography, and intrasplenic portal venography.

For splenography as performed by the authors, the patient is placed upon a Sanchez-Perez rapid cassette changer, which, in turn, is placed on any standard radiographic table. A special equipment tray assembled specifically for this procedure contains sterile drapes, sponges,

appropriate needles for local anesthesia and splenic puncture, syringes, and a flexible rubber connector. With the patient in place on the radiographic apparatus, a field in the region of the 9th and 10th left interspaces laterally is suitably prepared and draped. Local anesthesia is obtained, and a puncture is made with a 4-inch No. 18 needle, of a type commonly used in this institution for diagnostic splenic puncture. The needle is inserted through the lateral aspect of the 9th or 10th interspace in such a manner that its point passes cephalad and medially, with care not to engage the rib on either side of the interspace. This last precaution is important, since fixation of the needle in any manner is probably the leading single cause of rupture of the spleen during splenic puncture.

When a proper puncture has been performed, the hub of the needle and the visible portion of the shaft will move freely during respiration. A small aspiration syringe is then attached to the needle, and a specimen of splenic pulp is obtained. If an aspirate cannot be obtained, it has been found by the authors to be of little use to inject the contrast material, for in the absence of a relatively free flow of aspirate one is unlikely to produce diagnostic opacification of the splenic and portal venous systems.

While the puncture and aspiration are being performed by the hematologist, the radiologist fills with contrast material a 50 c.c. Luer-Lok syringe attached to a short, flexible rubber adaptor with Luer-Lok connections at either end. This adaptor is in turn joined to the splenic puncture needle after aspiration has been completed. The purpose of the rubber

¹ From the Departments of Radiology and Medicine, Western Reserve University School of Medicine and University Hospitals of Cleveland, Ohio. Presented at the Fortieth Annual Meeting of the Radiological Society of North America, Los Angeles, Calif., Dec. 5-10, 1954.

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TABLE I: APPEARANCE OF PUNCTURE SITES IN SPLEENS INJECTED PRIOR TO INSPECTION AT SURGERY OR AUTOPSY

Case	Race-Sex-Age	Time between Injection and Examination	Type of Examination	Results
AK	W. F. 52	6 hours	Emergency splenectomy	Rupture with hemorrhage
EM	W. F. 50	2 months	Routine splenectomy	Healed puncture. No old blood
WP	W. M. 22	4 days	Routine splenectomy	Small laceration. 100 c.c. old blood
ML	W. F. 50	1 hour	Routine splenectomy	Puncture site not found. No bleeding
AB	W. M. 58	2 hours	Routine splenectomy	Puncture site found. No significant bleeding
RT	W. F. 49	3 weeks	Autopsy	Puncture healed. No old blood

adaptor is to insure against fixation or torsion of the needle during injection.

Depending upon the size of the spleen, between 20 and 40 c.c. of 70 per cent Diodrast or 70 per cent Urokon has been used. Injection is performed rapidly, and exposure of films is begun after approximately one-fourth of the contrast material has been introduced. The authors have employed intervals of a half second to two seconds between successive exposures with the Sanchez-Perez unit, but the timing has not been found to be especially critical. An interval of two seconds would certainly be acceptable. Manual film changing—one film every three seconds—has been used in several cases and has also yielded sufficient films for diagnostic purposes.

The immediate complications of injection are those usually encountered with iodine-containing contrast materials injected rapidly. Flushing, a burning sensation in the mouth, and nausea have been noted. Likewise, it is not uncommon for a little reflux to occur about the opening of the needle in the capsule of the spleen, and the patient may complain of left upper quadrant pain. Occasionally this may radiate to either lower quadrant, to the epigastrium, or to the left shoulder. Abdominal pain is seldom severe or persistent enough to require medication. The longest duration of post-injection pain in this series was thirty minutes.

The most feared complication of splenic puncture is rupture of the spleen. Unfortunately there are probably no immediate symptoms to indicate the occurrence of this catastrophe. On the one occasion in the present series in which the spleen was torn, the puncture was done by an internist (not one of the authors) inexperienced

in the technic of splenic puncture. It was his misfortune to perform the puncture in such a way that the needle was fixed by the inferior margin of a rib and could not move freely during respiration. In the several hours following the puncture and splenography, clinical signs pointed to blood loss, and an emergency splenectomy was performed. A 2.5-cm. tear was discovered in the substance of the spleen at the site of injection. Although this was the only such instance in the series, it represents a thoroughly undesirable complication of a diagnostic study.

Diagnostic splenic puncture in itself seldom produces a splenic tear, but splenography imposes the additional trauma of sudden expansion of the substance of the spleen by the rapidly injected contrast material. Others have found that slow injection of the medium will not yield a satisfactory examination.

In addition to the unfortunate accident described above, 5 cases have furnished more favorable direct information concerning the condition of the spleen after puncture and injection (Table I). In 2 of these cases splenectomy was performed immediately after splenography, the patient having been brought to the Department of Radiology for the latter procedure on the way to the operating room. In 2 other cases splenectomy was done at a later date, but not as a consequence of splenography. In the sixth instance, the patient died and autopsy was performed. The findings in these 6 cases are summarized in Table I. It can be seen that, except for the case of definite rupture due to trauma by the needle during injection, no significant damage to the spleen, or bleeding from this organ, was noted.

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RESULTS

The authors early learned that the development of the films must be awaited with some uncertainty. Although little on this point is mentioned in the literature, it is possible to obtain two varieties of record



Fig. 1. The needle is in place in the lower pole of the spleen and no contrast material is visible in any part of the portal circulation. Instead, it appears to be distributed in the subcapsular area of the spleen itself. A little of the opaque material lies in the peritoneal cavity below the inferior pole of the spleen. This appearance persists throughout an unsuccessful examination.

in splenography. The desirable variety is illustrated by Figures 3 through 6, but record of failure (Fig. 1) is also obtained with alarming frequency. Unsatisfactory examination is seldom alluded to in the literature, and is probably best illustrated by Gvozdanovic *et al.* (11).

The authors, working with patients drawn predominantly from the lymphoma-leukemia group, encountered failure records in over 50 per cent of the examinations (10 out of 18). The appearance of the spleen is little altered throughout the series of films obtained, and the configuration of contrast material suggests that the medium is deposited under the capsule. With subcapsular deposition of contrast substance, it seems unlikely that opacification of splenic and portal venous systems will occur. The opaque material



Fig. 2. Considerable contrast material has escaped along the needle track and lies scattered about the abdominal cavity. Bowel distention was present prior to the examination.

maintains this configuration until its disappearance in one to four hours.

Another form of unsuccessful examination was recorded on one occasion early in the present series (Fig. 2). A little contrast material is seen within the spleen, but most of it has escaped and lies between bowel loops in the left side of the peritoneal cavity. Bowel distention was present prior to the injection.

Figures 3A, B, and C show an examination of the normal type. Figure 3A, made two seconds after the beginning of the series of films, shows contrast material in the substance of the spleen and under its capsule. The splenic vein is already opacified and is normal in course and caliber. Linear striations in the contrast material are observed in most records. Their significance is unknown. Five seconds after the beginning of the series, opacification has progressed to the portal vein and to many of its radicles in the liver (Fig. 3B). Figure 3C shows terminal branching of hepatic portal venous radicles. At least one group of authors has demonstrated space-occupying lesions within the

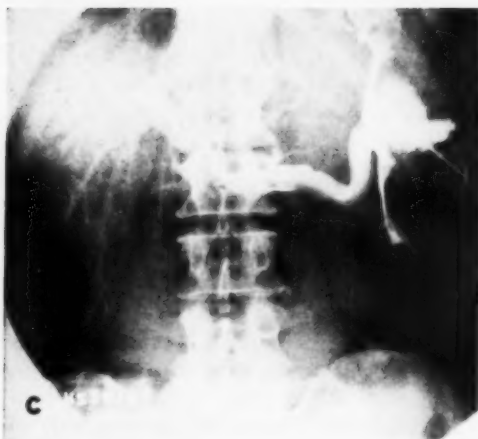
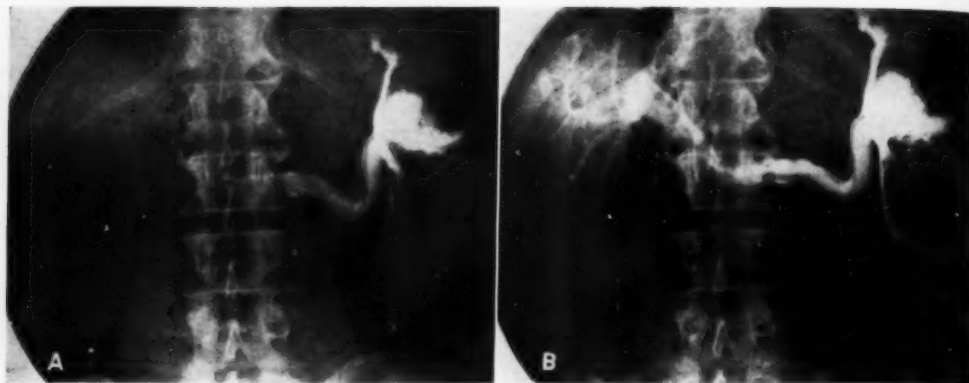


Fig. 3. A. Film made at two seconds after beginning of series shows contrast material within the substance and beneath the capsule of the spleen. The splenic vein is opacified and is of normal course and caliber. B. Film made five seconds after beginning of injection, showing opacification of portal vein and many major portal venous radicles in the liver. C. Film made seven seconds after beginning of series, showing a normal mode of circulation throughout. Moderate hepatosplenomegaly was present.

substance of the liver by means of displacement of opacified portal venous branches (6).

Figure 4 shows another type of normal examination in a somewhat larger and more obese person, in whom few small portal radicles are visible at nine seconds. This was likewise interpreted as a normal record. Although somewhat smaller in caliber in this patient, the splenic vein was still thought to be normal.

Abnormalities detected in the authors' series have been few in number, but the case illustrated in Figures 5A and B affirms the usefulness of splenography. The patient was a forty-nine-year-old white female with hepatosplenomegaly of unknown origin. A diagnostic splenic puncture was to be made, and splenography was performed as an afterthought. Early in the series (Fig. 5A), contrast material could be seen in the lower pole of the spleen and in the trunk of the splenic vein, which terminated just beyond the hilus of the spleen in a concave defect. A few smaller vessels were visible in the hilar region also, but the major amount of contrast material leaving the spleen did so by way of a trunk seem-

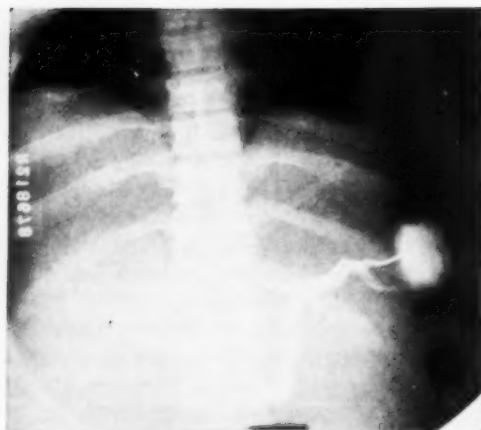


Fig. 4. The normal mode of circulation and distribution of radicles in an obese patient. Note that several trunks unite to form the splenic vein at the hilus of the spleen. The portal vein is not well demonstrated.

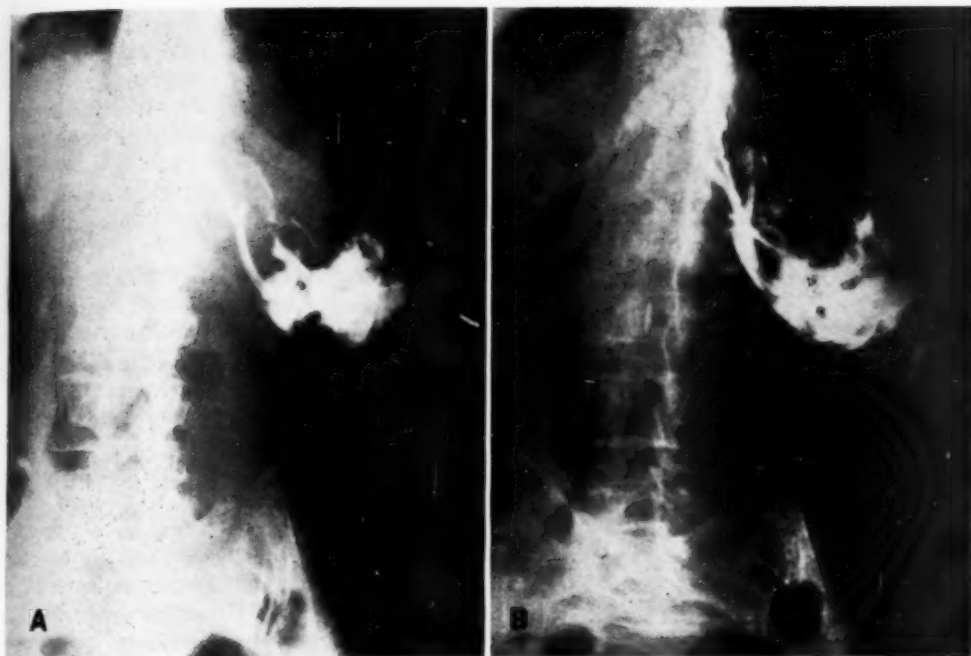


Fig. 5. A. Contrast material leaves the hilus of the spleen by means of the splenic vein but terminates in a concavity, representing obstruction. Contrast material also leaves the spleen by means of a vessel which seemingly arises at the lower pole and passes upward to the region of the upper end of the stomach.

B. Contrast material communicating with a nest of varices at the upper end of the stomach and in the region of the lower esophagus. The medium enters the portal circulation by means of collaterals along the lesser curvature of the stomach.

ingly arising near the lower pole of the spleen and communicating with the region of the upper end of the stomach. Anatomically, this was identified as the short gastric vein. Figure 5B represents a somewhat enlarged view of a later film in this series, showing contrast material entering a nest of varices in the region of the upper end of the stomach and lower esophagus. Contrast material is seen entering the portal circulation by means of collaterals along the lesser curvature of the stomach. This record was interpreted as showing obstruction of the splenic vein and esophageal and gastric varices. The presence of the latter was not suspected clinically, and a somewhat unsatisfactory barium examination of this region had failed to disclose shadows consistent with a diagnosis of varices. At autopsy, some time later, obstruction of the splenic vein due to compression by an enlarged node

near the hilus of the spleen was definitely shown. Dye injection into the circulation at the upper end of the stomach confirmed the presence of varices.

The clear demonstration of esophageal varices in this case, and as observed by other writers, is the best radiographic evidence of the presence of varices now obtainable short of portal venography performed during laparotomy.

Figure 6 represents an as yet unsolved problem in a patient suspected of having splenic vein obstruction. The blunt shadow in the region of the hilus of the spleen has been interpreted by some as implying obstruction of the splenic vein, but much of the contrast material lies under the capsule of the spleen. The parallel linear shadows outside the spleen and under the diaphragm lie upon, or within, the bowel. The only contrast material leaving the spleen is seen in a barely perceptible atypi-



Fig. 6. Most of contrast material is retained within the spleen, apparently below the capsule. Some lies outside on the bowel. The blunt triangular shadow at the hilum is thought by some to represent an obstructed splenic vein. Some contrast material left the spleen through a small atypical collateral vessel seen at the bottom of the film.

cal collateral vessel arising from the lower pole of the spleen, passing downward and medially to the left upper quadrant. Anatomical confirmation is lacking in this case, and the findings may be of no diagnostic significance.

DISCUSSION

It is apparent that a mechanical disturbance of the portal circulation might be investigated by splenography; occlusion by thrombosis and extrinsic pressure can also be demonstrated. Esophageal varices can be visualized, and there is no doubt that splenography affords the best radiographic proof of their existence obtainable without laparotomy.

The future of splenography may well lie in those cases in which splenomegaly is present and esophageal varices are suspected. There is no doubt of the superiority of the demonstration of varices by direct opacification to deduction of their existence from defects in a barium column. A major application of splenography might be in the evaluation of the portal venous system before or after surgical revision, but the authors have had little occasion to test this application.

There are several serious deterrents to

the widespread use of splenography. One is the ever-present danger of rupture of the spleen. This danger is so considerable that the authors have developed a set of criteria to which any patient submitted to splenography must conform.

1. The spleen must be readily palpable and it must be firm. Otherwise puncture will not be performed.

2. The puncture must be done in such a way that the needle is at all times freely movable during respiration, or the needle must be removed.

3. A free flow of aspirate from the spleen to the aspiration syringe must be obtained. Otherwise contrast material should not be injected, even though a puncture has been made.

4. Under no circumstances should splenography be performed on any patient in whom splenectomy is contraindicated for medical reasons. Hypoprothrombinemia or thrombocytopenia may or may not constitute a contraindication, depending on the individual patient.

If all of these criteria can be satisfied, then contrast material can be injected, but one is by no means certain of obtaining a diagnostic record, at least in patients suffering from lymphomas or leukemias. As has been pointed out above, the authors obtained failure records in over 50 per cent of their cases. This possibility must, therefore, be carefully weighed whenever splenography is to be undertaken.

It has been suggested that at least one unit of blood, suitably typed and cross-matched, be available for each patient undergoing splenography. It is clearly advisable to watch the patient rather closely in the few hours following the procedure, and to inspect him regularly during the ensuing week in view of the possibility of late hemorrhage from a lacerated spleen.

The only circumstance under which the criteria for splenography outlined above might be disregarded is the case of the patient who is to undergo splenectomy or laparotomy in the immediate future and on whom advance information regarding

the status of the splenic and portal circulations is essential.

If splenography is to be used, therefore, the need for it in any individual case must outweigh the risk of rupture of the spleen, as well as the ever-present possibility that a diagnostic record may not be obtained, and that puncture may have been performed in vain. In all cases of splenomegaly of unknown etiology splenic aspiration may well be indicated in itself in spite of these considerations.

SUMMARY

1. Splenography has been performed by the authors in 18 patients drawn chiefly from the lymphoma-leukemia group.

2. In 10 instances the examination was unsatisfactory. Anatomical correlation was obtained in 6 cases.

3. Splenography affords the best possible demonstration of esophageal varices short of laparotomy.

4. Splenography has been advised as a means of evaluating the portal venous system preoperatively, but the authors have not had adequate opportunity to evaluate the procedure in this respect.

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SUMARIO

Justipreciación de la Venografía Portal Ejecutada por Inyección Intrasplénica de Medio de Contraste (Esplenografía)

Preséntanse aquí observaciones acerca de la esplenografía (esplenopografía) en 18 enfermos. En 10 de los casos, el examen fué un fracaso, y en ellos se observó que la substancia de contraste se había depositado debajo de la cápsula esplénica.

El procedimiento resultó en particular útil para descubrir várices esofágicas y parece ofrecer la mejor visualización de esas lesiones, excluida la laparotomía.

La rotura del bazo es la complicación que hay que temer más.

Uncomplicated Dextroversion of the Heart¹

RICHARD A. WELSH, M.D., and BENJAMIN FELSON, M.D.

DEXTROVERSION of the heart is a form of dextrocardia resulting from congenital malrotation of the heart about its long axis. The earliest reference to the condition is credited to Paltauf (1), who, in 1901, differentiated it from the other forms of dextrocardia. Since then, a considerable volume of information regarding this type of right-sided heart has accumulated (2-12). In spite of the fact that the radiologist is often the first to be confronted with the anomaly, only scant information concerning it is available in the radiological literature. It is our purpose to emphasize that dextroversion may exist in association with an otherwise normally developed heart and to describe the findings in these uncomplicated cases, which occur with considerably greater frequency than earlier writers have implied.

Some confusion of nomenclature and classification is apparent in the literature on dextrocardia. In an effort to clarify this subject, and to orient the reader with respect to the specific entity of dextroversion, Table I has been compiled. The classification given does not differ greatly from that employed in several previous articles.

A detailed discussion of dextrocardia of Types I, II, and IV is beyond the scope of this paper.

EMBRYOLOGY; PATHOLOGIC ANATOMY

The basic developmental defect in Type II dextrocardia occurs in the second week of fetal life. At that time the primary cardiac tube begins to grow more rapidly than the surrounding thoracic structures. For this reason, in the normal fetus, the cardiac anlage doubles on itself to form an S-shaped curve. If, instead, the primordial cardiovascular structure bends in a counter-sigmoid direction, Type II dextro-

cardia with complete inversion of cardiac chambers results.

In uncomplicated dextroversion, this initial embryologic phase is believed to be entirely normal, and development progresses without complication until approximately the sixth week of intrauterine life. The heart is then well differentiated and occupies a position in the thorax close to the mid-line. At this time the next normal step in development occurs, namely, rotation of the heart to the left about its long axis. This results in normal cardiac position and configuration. If rotation about the long axis occurs to the right instead of to the left, dextroversion results (2).

The pathologic anatomy resulting from this error in development varies with the degree of the malrotation. In full-blown cases of dextroversion, the left ventricle is rotated to an anterior position, forming the major portion of the anterior surface of the heart. The right ventricle lies well to the right and constitutes the right cardiac border. The right atrium occupies the posterior aspect of the heart and the left atrium comprises most of the left cardiac border (7). The ascending aorta and pulmonary artery are apparently rotated to a relatively smaller degree than the heart itself. Lesser amounts of rotation cause proportionately less displacement of the chambers, and complete failure of rotation gives rise to mesocardia, or mid-line position of the heart (Fig. 4).

CLINICAL FINDINGS

Because the heart functions normally in uncomplicated dextroversion, there are no cardiac or other symptoms attributable to the anomaly. On physical examination, the area of cardiac dullness lies in the right thorax. The point of maximum impulse, however, is either diffuse or is found close

¹ From the Department of Radiology, University of Cincinnati College of Medicine and Cincinnati General Hospital. Accepted for publication in November 1954.

TABLE I: CLASSIFICATION OF DEXTROCARDIA

Pathological Type	Synonyms	Etiologic Factors	Associated Pathologic Findings
Type I: Dextrocardia with complete transposition of viscera	Situs inversus totalis Mirror image dextrocardia	All organs develop in reverse fashion. Cause unknown	Normally functioning cardiovascular system. High incidence of bronchiectasis and sinusitis (Kartagener's syndrome)
Type II: Dextrocardia without transposition of other viscera but with inversion of cardiac chambers			
A. Complete	A. Situs inversus partialis Pure dextrocardia Isolated dextrocardia	A. Malrotation of primary cardiac tube. Occurs two weeks after fertilization of ovum	A. Invariably associated with other congenital cardiac anomalies
B. Partial	B. Dextrocardia with corrected transposition	B. Same as above plus transposition of aorta and pulmonary artery	B. None, if anatomically perfect transposition occurs (rare)
Type III: Dextrocardia without transposition of viscera and without inversion of cardiac chambers	Dextroversion of the heart Dextrorotation of the heart Incomplete rotation of the heart Pseudo situs inversus partialis	Heart rotates in reverse about its long axis in sixth week of fetal life	
A. Complicated			A. Associated with other congenital cardiac anomalies
B. Uncomplicated			B. None
Type IV: Dextrocardia due to factors extrinsic to the heart	Secondary dextrocardia Dextroposition of the heart	Thoracic wall deformities Pulmonary disease Pleural disease Eventration of left diaphragm	Cardiac function impaired only in so far as mechanical effect on circulatory apparatus occurs

to the sternum, in contradistinction to its location near the right mid-clavicular line in dextrocardia of Types I and II. This feature helps in the clinical differentiation between dextroversion and the types of dextrocardia which show chamber inversion. No murmurs or arrhythmias are encountered in patients with uncomplicated dextroversion.

The electrocardiogram ordinarily shows little or no deviation from the normal. This is another aid in differentiating dextroversion from the types of dextrocardia with inversion of cardiac chambers (Types I and II). Many authors, however, have pointed out the inadequacy of the electrocardiogram in the diagnosis of Type II dextrocardia, since the associated cardiac anomalies may cause electrocardiographic changes which completely mask the evidence of inversion of chambers (2-4).

ROENTGEN FINDINGS

Although it has generally been considered impossible to make the diagnosis of dextroversion with certainty by conventional roentgen technics, we feel that there are a number of signs which, when taken together, virtually exclude all other possibilities. This is particularly true when the heart is found to be functionally normal. The single entity which cannot be completely eliminated is Type II B dextrocardia, in which the chamber inversion is functionally corrected by anatomically perfect transposition of the aorta and pulmonary artery. Such cases are exceedingly rare. Even in these instances the electrocardiogram should indicate the chamber inversion (7).

The following significant roentgen signs of uncomplicated dextroversion have been observed:



Fig. 1. Case I. Asymptomatic white female, aged 32. No cardiac murmurs. Electrocardiogram normal. Heart predominantly in right thorax, with aortic knob normal in location. Note abnormal cardiac configuration.

1. The heart lies predominantly in the right thorax (Fig. 1).

2. The aortic knob retains its normal position on the left side (Fig. 3A), since the aortic arch develops independently of the heart. This is an invariable finding in dextroversion, while it is encountered in only about one-fourth of the cases of Type II dextrocardia, and practically never in Type I.

3. The cardiac contour as seen on the frontal projection is peculiar (Figs. 1 and 2A). The unusual configuration results largely from the absence of the profile of the normal cardiac apex. This finding is best revealed by reversing the film. When this is done in cases of mirror image dextrocardia (Type I), a normal cardiac configuration is observed. In Type II dextrocardia, although the silhouette may be somewhat distorted by the associated anomalies, a cardiac apex can usually be seen on the reversed film, and some semblance of a normal heart outline is often apparent. In dextroversion, on the other hand, no tapering conical apex is present, and the reversed silhouette maintains a bizarre appearance.

4. The convex shadow of the pul-

monary arc is usually not visible in the frontal view on either the right or left side (Fig. 3A). This is attributable to the abnormal position of the right ventricle.

5. The aorta and pulmonary artery are relatively normal in position. This is apparent in the oblique views which, incidentally, have received little consideration in previous articles on dextroversion. In our experience, these vessels appear considerably less rotated than the heart itself. This is evident fluoroscopically by the observation that the degree of right anterior obliquity required to project the pulmonary artery into maximum prominence (Figs. 2C and 3C), and the degree of left anterior obliquity needed to "uncoil" the aortic arch (Fig. 3D) are little different from the normal.

6. Slight rotation (10 to 15°) into the right oblique position often results in a silhouette closely resembling a normal frontal cardiac contour (Fig. 6A).

7. On fluoroscopy in the frontal projection, the pulsation of the heart is usually more forceful on the right cardiac border than on the left. This is true because the right border is formed by the right ventricle while the left is defined by the left atrium.

8. The abdominal viscera lie in normal position. Type I dextrocardia is thereby eliminated from consideration.

9. There is no thoracic cage deformity or evidence of pleural or pulmonary abnormality which might displace the heart to the right. This finding differentiates dextroversion from Type IV, or secondary, dextrocardia.

10. The left diaphragm is usually higher than the right (Fig. 3A), although this is not invariably true (Fig. 1). This sign is of no aid in differentiating dextroversion from other types of dextrocardia.

11. Cardiac catheterization enabled Chapman and Gibbons to verify the diagnosis of uncomplicated dextroversion in one instance (6). They localized the cardiac chambers by correlating the position of the catheter tip with the pressure readings.

12. Angiocardiography also affords a

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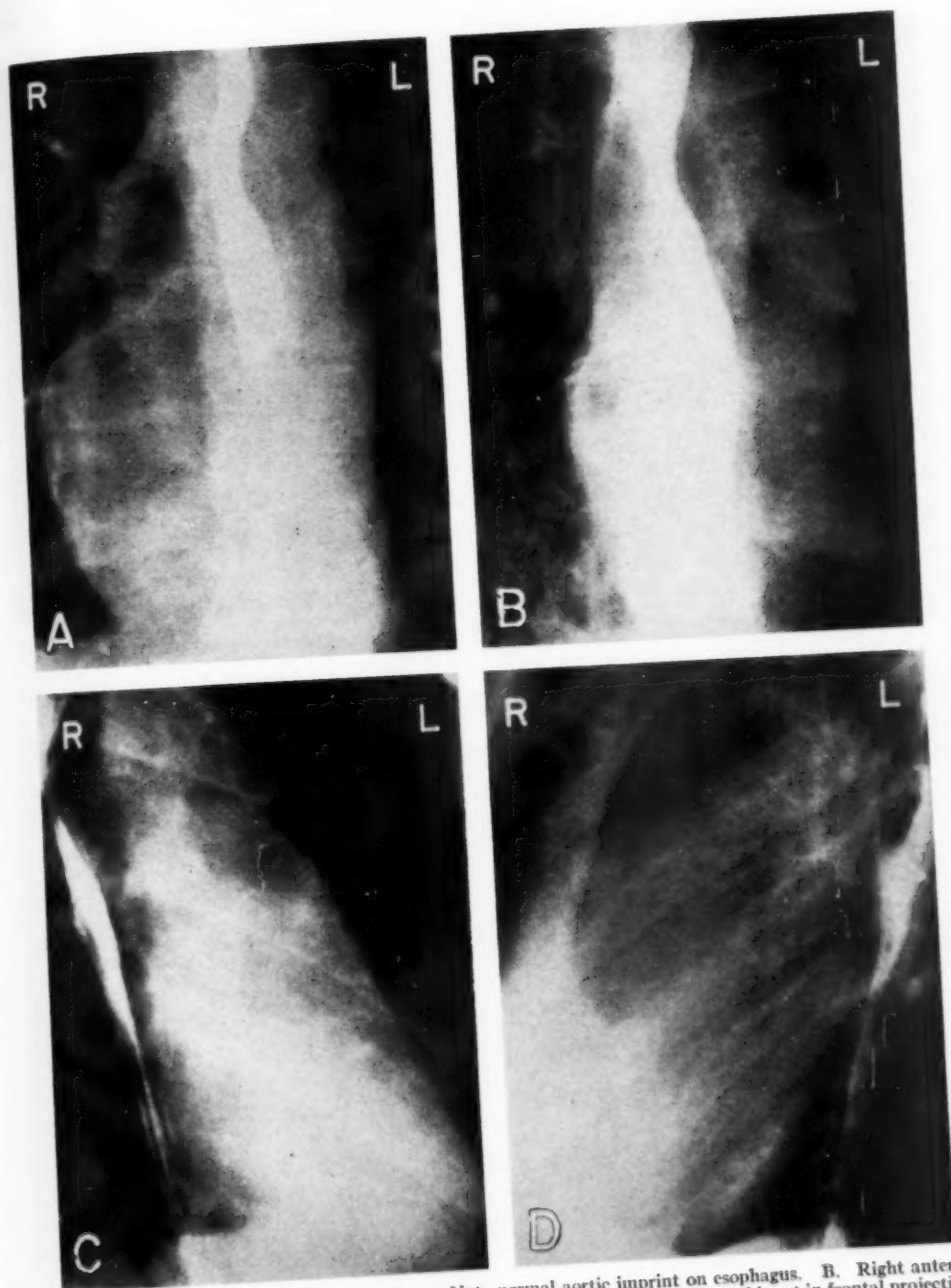


Fig. 2. Case I. A. Postero-anterior view. Note normal aortic imprint on esophagus. B. Right anterior oblique view, 15° rotation. The contour and position now resemble those of a normal heart in frontal projection, except for prominence of the pulmonary artery segment. C. Right oblique, about 50° rotation. D. Left oblique, 70°.

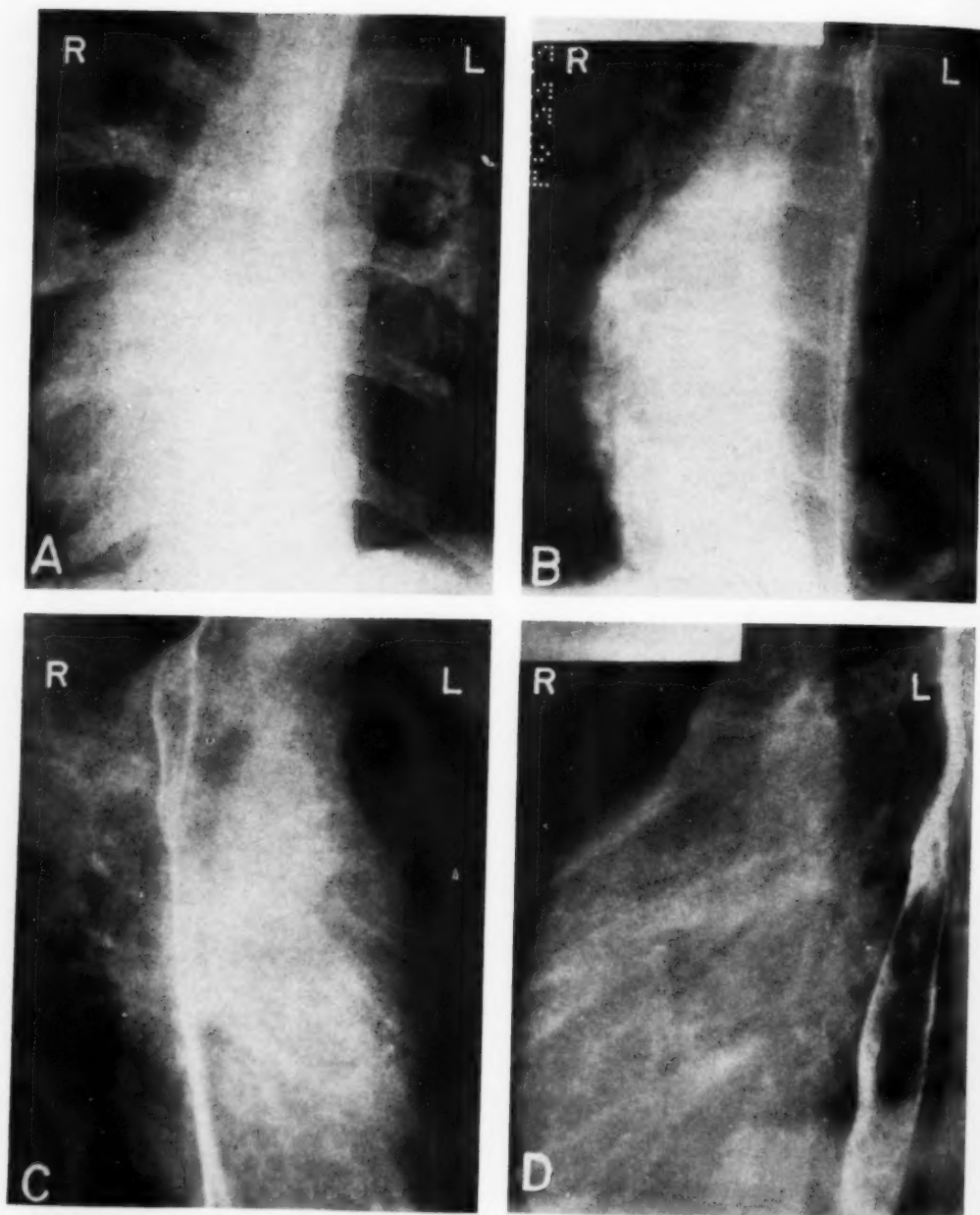


Fig. 3. Case II. Colored male, aged 29. No cardiac symptoms. No murmurs. Electrocardiogram normal. A. Postero-anterior view. Aortic knob on left. Pulmonary artery prominence not seen on right or left. Pulsations were more forceful on right border than on left. B. Right anterior oblique view, 15° rotation. C. Right oblique, 60°. D. Left oblique, 60°. The pulmonary artery and ascending aorta appear almost normal for the oblique positions, but the heart does not.

means of confirming the diagnosis of dextroversion. Steinberg *et al.* (3), in an article dealing with the angiocardigraphic

findings in dextrocardia, included 2 cases of dextroversion studied by this method. They found that the right ventricle formed

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the right cardiac border in both cases. Burchell and Pugh (4), in a report of 4 cases of dextroversion, cited 1 in which angiocardigraphy had been performed because of atypical electrocardiographic findings. In this case, also, the frontal angiogram revealed the right ventricle on the extreme right side of the heart. Later films in the series demonstrated that the left atrium formed the left cardiac border and the left ventricle, as anticipated, lay in a fairly mid-line position, its apex directed slightly toward the right. The only case in our series in which an angiocardigram was obtained was complicated by an interatrial septal defect. Nevertheless, the study revealed the same relative positions of the cardiac chambers as in the cases reported by the other authors (Fig. 7).

In summary, the criteria for the diagnosis of uncomplicated dextroversion are: a functionally normal heart; normal relationships of the cardiac chambers as shown electrocardiographically; a right-sided heart with a normally located aortic knob; normal position of the abdominal viscera; and absence of any extracardiac

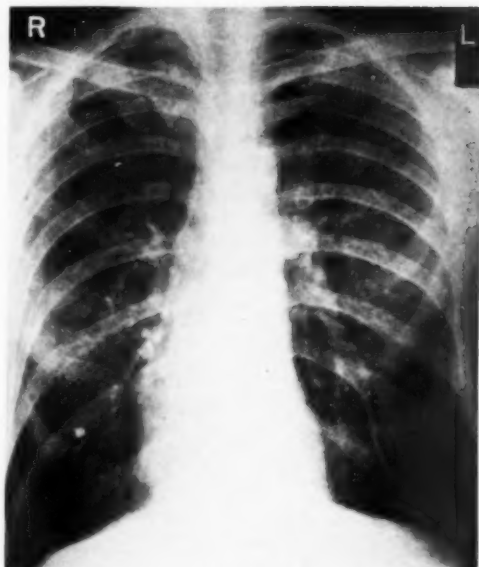


Fig. 4. Case III. White male, aged 72, with no cardiac symptoms or signs, and essentially normal electrocardiogram. Mid-line position of heart (mesocardia). There was no deformity of the thoracic cage.

abnormality which might cause displacement of the heart. To establish the diagnosis when the anomaly is complicated by other malformations, one must resort

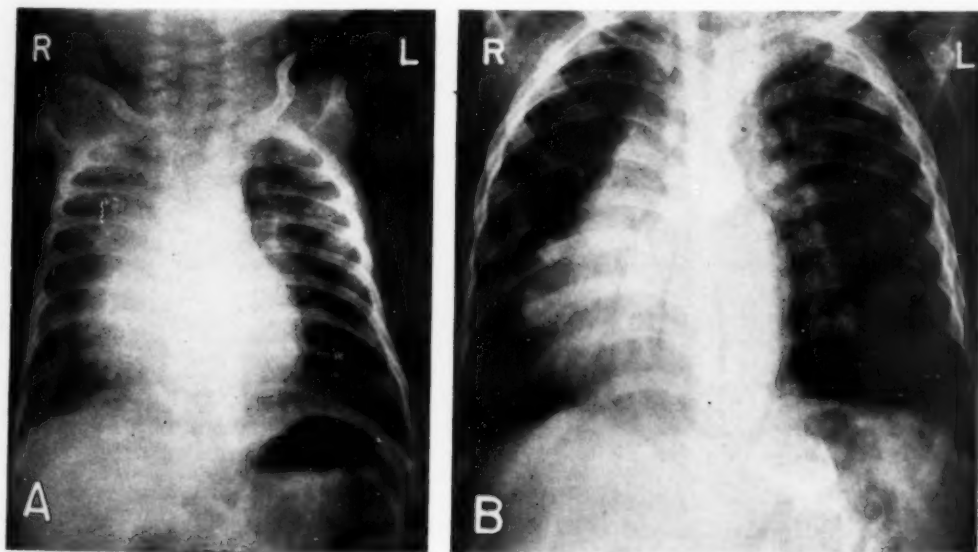


Fig. 5. Case VII. Postero-anterior roentgenograms. A. At birth. B. At two years. Enlarged right-sided heart and pulmonary over-circulation. Left diaphragm slightly higher than right. Note normal situs of abdominal viscera.

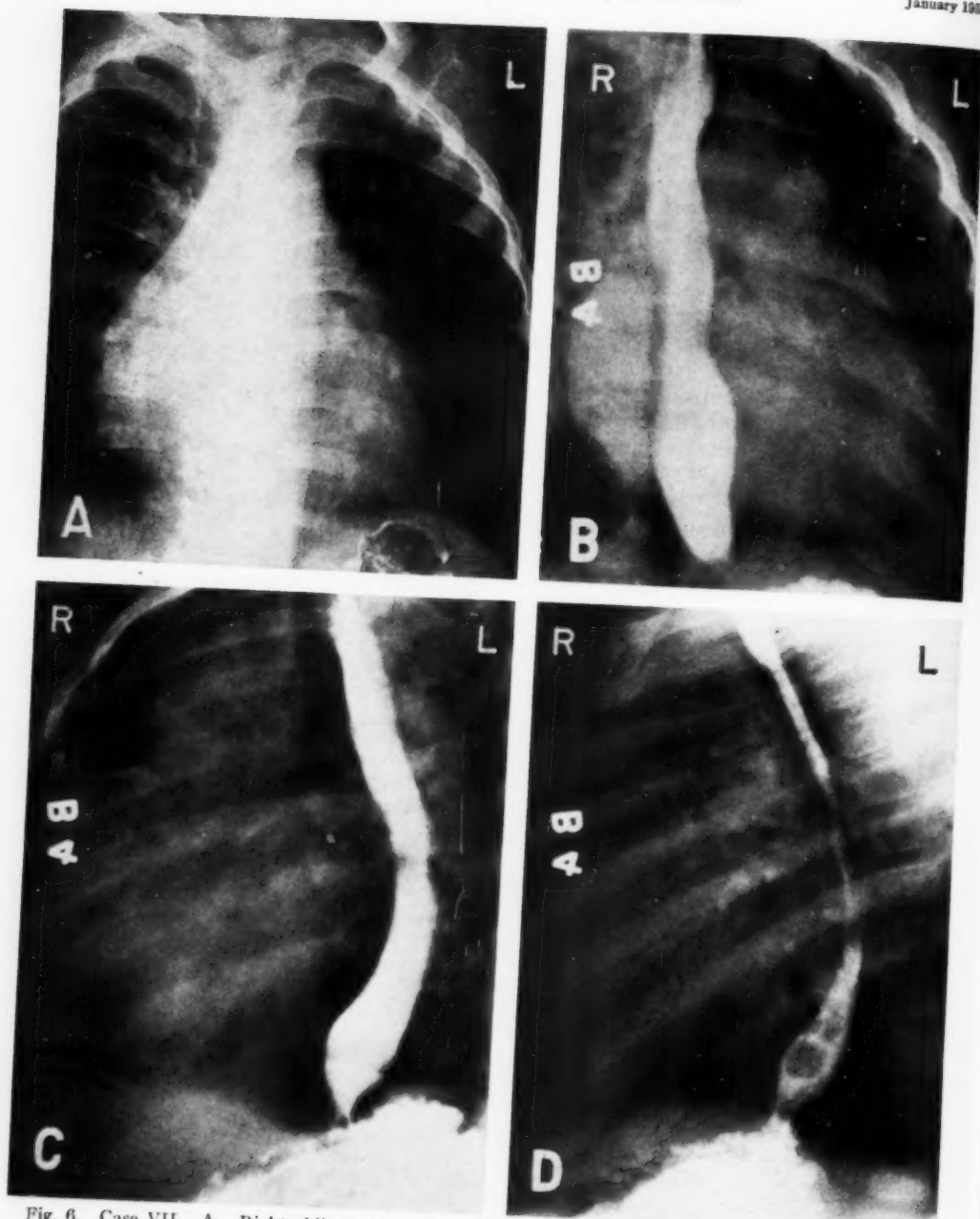


Fig. 6. Case VII. A. Right oblique, 10°. Contour and position of heart are those of a normal frontal projection. B. Right oblique, 35°. The pulmonary artery segment is prominent. C. Left oblique, 50°. D. Left lateral.

to cardiac catheterization and/or angiography.

In the past year 6 cases which fulfill the clinical, electrocardiographic, and roentgen

criteria of uncomplicated dextroversion were examined at the Cincinnati General Hospital, including 1 in a newborn infant. It was not deemed justifiable to subject

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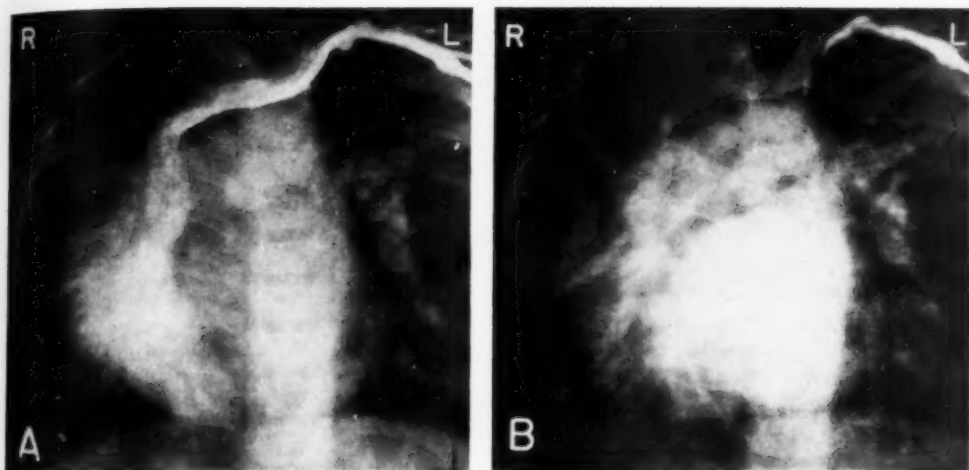


Fig. 7. Case VII. Anteroposterior angiocardigram. A. Two seconds after injection. Opacified right atrium and ventricle partially superimposed. Right ventricle forming the right cardiac border. Faint opacification of the left atrium through an atrial septal defect, noted on the original film, is poorly reproduced. B. Six seconds later. The opacified left atrium and left ventricle overlap. The left atrium forms most of the left cardiac profile.

any of these well patients to angiocardiology or cardiac catheterization. A seventh case, complicated by an additional cardiac malformation, was also seen. This case is reported (even though it is not an example of uncomplicated dextroversion) because it demonstrates the angiocardigraphic findings of dextroversion.

CASE VII (reported through the courtesy of Dr. Frederic N. Silverman): A 2-year-old colored male had manifested signs and symptoms of congenital heart disease since birth. A history of intermittent dyspnea and frequent respiratory infections was obtained. On physical examination there was evidence of retarded growth, but no cyanosis or clubbing of the fingers. An area of cardiac dullness was percussed in the right thorax. A harsh Grade IV systolic murmur, heard best near the sternal border in the right third interspace, was present. Laboratory findings were normal. The electrocardiogram revealed no evidence of chamber inversion but showed right ventricular hypertrophy.

A chest film at birth (Fig. 5A) and fluoroscopic and radiographic examination at the age of two years (Figs. 5B and 6) showed the heart to be located chiefly on the right. Cardiac enlargement (predominantly of the right chambers) and mild pulmonary over-circulation were also demonstrated. A diagnosis of interatrial septal defect with isolated dextrocardia (Type II) was considered most likely.

Angiocardiology demonstrated that the right atrium and the right ventricle were right-sided, the ventricle forming the right cardiac margin (Fig.

7A). Later films in the series (Fig. 7B) indicated that the left atrium contributed largely to the left cardiac border. The left ventricle was close to the mid-line, presumably anterior in location, and partly superimposed over the left atrium. Thus, dextroversion rather than Type II dextrocardia accounted for the abnormal position of this patient's heart. Early filling of the left atrium and increased vascularity of the lungs confirmed the clinical diagnosis of interatrial shunt.

SUMMARY

1. Dextroversion is a form of dextrocardia resulting from congenital malrotation of the heart. In its embryologic aspects, it differs fundamentally from other types of dextrocardia. It may occur either as an isolated anomaly or may be complicated by other forms of congenital heart disease.

2. The diagnosis of uncomplicated dextroversion can be made with reasonable certainty on the basis of a normally functioning heart, normal relationship of the cardiac chambers electrocardiographically, and roentgen evidence of right-sided heart with normally located aortic knob, normal position of the abdominal viscera, and absence of obvious extracardiac disease to account for the cardiac displacement.

3. In the presence of associated anomalies, cardiac catheterization or angiocardi-

ography may be helpful in establishing the diagnosis of dextroversion.

4. The present report is based on 6 uncomplicated cases. A seventh case, complicated by an interatrial septal defect, is included because it demonstrates the angiocardigraphic findings of dextroversion.

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ACKNOWLEDGMENT: The authors are indebted to Dr. Frederic N. Silverman, Children's Hospital, for Case VII, and to Dr. Lee S. Rosenberg, Jewish Hospital, for his kind assistance.

ADDENDUM: Since this paper was submitted, we have encountered 3 additional cases, in 1 of which angiocardiology was performed. The roentgen findings were identical with those described above.

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SUMARIO

Dextroversión Cardíaca Simple

La dextroversión es una forma de dextrocardia debida a mala rotación del corazón, que, en sus aspectos embriológicos, discrepa fundamentalmente de otras formas de dextrocardia. Puede presentarse ya como anomalía aislada o unida a otras formas de cardiopatía congénita.

Cabe hacer el diagnóstico de la dextroversión sin complicaciones con bastante certeza a base de un corazón de funcionamiento normal, relación normal electrocardiográficamente de las cavidades cardíacas y signos roentgenológicos de corazón dextrorotacional con situación normal del

cayado aórtico, posición normal de las vísceras abdominales y falta de manifiesta afección extracardiaca que ocasione el desplazamiento cardíaco.

Cuando existen otras anomalías, el cateterismo cardíaco o la angiocardigrafía pueden resultar útiles para establecer el diagnóstico de dextroversión.

La comunicación actual se basa en 6 casos sin complicaciones. Se presenta un 7° caso, complicado por inoclusión del tabique interauricular, por mostrar los hallazgos angiocardiógráficos de la dextroversión.



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Protrusio Acetabuli in Rheumatoid Arthritis¹

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and HAROLD G. JACOBSON, M.D., F.A.C.R.⁴

PROTRUSIO ACETABULI (arthrokatadysia, Otto pelvis) has been defined as "an affection of the hip joint characterized anatomically by deepening of the acetabulum with mesial displacement of the inner wall" (1). A. W. Otto (2) described this condition in 1824 and attributed it to "abnormal gout." White (3), in 1884, contributed the first case to the English literature, and Hertzler (1), in 1922, made the first report in the American literature. Extensive contributions are found in the German literature. The name of Chrobak is frequently associated with protrusio acetabuli in these reports, and the condition is sometimes referred to as the Chrobak or Otto-Chrobak pelvis.

It soon became evident that the cases fell into two large categories: (a) those in which no evidence of focal hip disease was present and in which protrusions usually were bilateral; (b) cases in which primary focal hip disease was clearly manifest and in which the protrusio was usually unilateral. The former group was termed "primary protrusion," "Otto's disease" or "true Otto pelvis." The latter group was called "secondary protrusion." Some classifications (4) include a third small group of "juvenile protrusion," in which the condition is attributed to developmental abnormalities in the triradiate cartilage.

There is general agreement that intra-pelvic protrusion of the acetabulum is a syndrome rather than a disease entity, and that a wide range of etiologic factors may be responsible. Thirty-one causes have been found for secondary protrusions in surveys of the literature (5). Whenever a disease process involves the acetabulum,

with preservation of the boring properties of the femoral head, protrusion may result. Pomeranz (6) feels that its occurrence depends on the relationship between bone destruction and regeneration and the forces applied. In general, rapid severe destructive processes involving both the acetabulum and the femoral head lead to bony ankylosis, whereas conditions which produce a localized acetabular decalcification are likely to result in protrusion.

The list of entities in which protrusion has been observed spans the gamut of disease categories. Tuberculosis, Neisserian infection, tabes, syphilis, Paget's disease, various endocrine disorders (such as hyperparathyroidism), gout, chondrodystrophy, trauma, echinococcus infestation, metastatic cancer, and congenitally deep acetabula have all been implicated. The arthritic conditions described are generally those having an osteoarthritic background.

With respect to rheumatoid arthritis, a review of the recent literature discloses varying and indefinite opinions. Berg, in 1940 (7), stated that "as far as can be determined, associated generalized rheumatoid changes have not been seen." Brailsford (8), on the other hand, states that "this condition of protrusio acetabuli is seen most frequently in multiple arthritis—as in rheumatoid arthritis and in gonorrheal arthritis." Golding (9), in 1934, wrote of a group of acetabular protrusions in which "the etiology . . . is the etiology of chronic rheumatic affections in general." Levin (10) stated (1935) that "rheumatic infections seem to be the cause of a number of cases." Pomeranz, in 1932, reviewed

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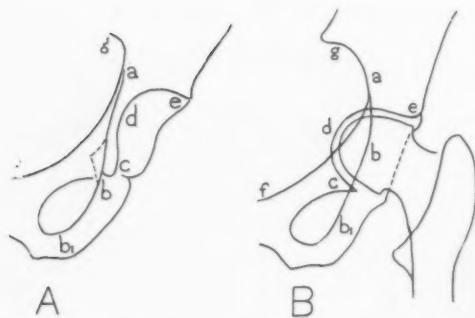


Fig. 1. A. The normal acetabulum. *abcd*. "Tear drop" figure. *cde*. Contour of acetabulum (floor). *abb₁*. Inner wall of pelvis. *bc*. Pelvis where anterior opening of acetabular fossa curves around to join inner wall of pelvis. Space between *abb₁* and *cde* is the thickness of the acetabular floor. *fg*. Pelvic brim. *ab*. Arcuate line. (From KÖHLER, A.: Roentgenology, New York, Wm. Wood & Co., 1928.)

B. Typical protrusio acetabuli. The curve of the acetabular floor (*cde*) sweeps across the inner wall of the pelvis (*abb₁*) and is projected within the curve of the pelvic brim (*fg*). No "tear drop" figure is seen. (From GILMOUR, J.: Brit. J. Surg. 26: 670-699, April 1939.)

79 cases of primary and secondary protrusions, in 6 of which there was a fairly definite diagnosis of rheumatoid arthritis. In 1951 Scandalis *et al.* (5) reported protrusio in a single case of rheumatoid arthritis. Additional scattered records exist, but documentation is usually inadequate.

The symptoms in acetabular protrusion are frequently related to the underlying cause. Pain and limitation of motion are not uncommon. Physical findings also are influenced by the primary disease. Characteristically, there is limitation of abduction, with shortening of the involved extremity. A flexion deformity of the involved hip is not unusual. An increase in the lumbar lordosis and a "waddling gait" are frequently found. The femoral head protrusion often causes a globular mass, palpable abdominally, rectally, or vaginally. Pelvic measurements may show an increase in the intercrystal diameter and a decrease in the intertrochanteric and intertuberous diameters.

Although clinical diagnosis is possible in advanced cases, roentgenography of the hip is required to detect the early stages of protrusion. Standard conditions for roentgen examination of the acetabulum

have been defined by Köhler (11). The central ray must be projected vertically through the mid-line of the pelvis (patient supine) and not over the hip joint itself. If this technic is followed, a "tear drop figure" (Fig. 1 A) is seen on the roentgenogram of the normal acetabulum. Distor-



Fig. 2. R. C., forty-eight-year-old female with rheumatoid arthritis of right hip. Moderate protrusio acetabuli and flattening of femoral head.

tions of this normal configuration are evident when protrusion is present (Fig. 1 B).

The extent of protrusion varies from a few millimeters to 5 cm. The acetabulum migrates inward, upward, and forward, projecting into the pelvis as a dome-shaped mass. It may project above the pubic ramus and may encroach upon the obturator fossa. The femoral head is usually preserved but may be mushroomed or elongated. As it follows the acetabulum into the pelvis, the trochanters approach the pelvic margins. The greater trochanter impinges on the ilium above the acetabulum and the lesser trochanter approaches the ischium, resulting in limitation of motion at the hip, as observed clinically. Further protrusion is halted by the arrest

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Fig. 3. J. K., fifty-three-year-old male with rheumatoid arthritis of both hips and bilateral protrusio acetabuli of moderate degree.

Fig. 4. E. D., fifty-seven-year-old female with rheumatoid arthritis of both hips and marked bilateral protrusio acetabuli with avascular necrosis of each femoral head.

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Fig. 5. Twenty-five-year-old male with rheumatoid arthritis of both hips and moderate bilateral protrusion.

Fig. 6. A. N., thirty-eight-year-old female with rheumatoid arthritis of both hips and slight to moderate right-sided protrusio acetabuli.

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of the trochanters at the lateral margins of the pelvis, at which stage the boring action of the head is no longer possible and the active phase of the disease is therefore terminated.

The present study is designed to determine the incidence of protrusio acetabuli

cases are shown in Figures 2-7. On evaluating the data the following points have impressed us:

1. Although primary acetabular protrusion is supposedly seen in females twice as often as in males, our cases of secondary protrusion showed no sex predilection,



Fig. 7. Case from Newington, Conn. Rheumatoid arthritis of both hips and extreme bilateral protrusio acetabuli.

in rheumatoid arthritis of the hip. One of the authors (McEwen) became interested in this problem after seeing such a case in consultation (in Newington, Conn.) and a survey of the material at the Hospital for Special Surgery was undertaken. One hundred patients with rheumatoid disease of one or both hips were examined and 5 cases with protrusion were found. Two additional cases have been seen at the New York Hospital and the New York University-Bellevue Medical Center. We have thus collected a total of 8 cases of protrusion in rheumatoid disease. We were able to obtain adequate clinical data in 6 (Table I). Roentgenograms of these

with 3 males and 3 females comprising the series.

2. An equal number of cases with bilateral and unilateral involvement is noted. The frequency of bilateral involvement can perhaps be explained by the diffuse nature of rheumatoid arthritis. It is essentially a systemic rather than a focal disease. Most of the patients had widespread joint involvement and 2 had rheumatoid spondylitis. Note that the 2 patients with rheumatoid spondylitis had bilateral acetabular protrusio. The unilateral cases were right-sided.

3. The long duration of the rheumatoid process in all of the cases is impressive.

TABLE I: OBSERVATIONS IN 6 CASES OF ACETABULAR PROTRUSION ASSOCIATED WITH RHEUMATOID ARTHRITIS OF THE HIP

Case, Sex and Age	Duration of Hip Symptoms (years)	Duration of Rheumatic History (years)	Side Involved	Symptoms Referable to Hip	Physical Findings in Hip	Other Joints Involved	Severity of Protrusion	Extent and Severity of Rheumatic Disease (Grades 1-4)	Was Spondylitis Present?
R. C. F48	2	8	Right	No pain; no swelling. Guarded gait	No pain on motion. Normal range of motion	Hands, knees, feet	Moderate, with mushroomed femoral head	Extent 4 Severity 2-3 Incap. 60-70%	No
T. B. M58	10	10	Right	Pain, swelling, limitation of motion	Pain, limitation of motion (50% of normal range)	Hands, wrists, shoulders, knees, ankles	Marked, with partial disintegration of femoral head	Extent 4 Severity 4 Incap. 100%	No
J. K. M53	9	20	Bilateral	Pain, swelling, limitation of motion	Both hips fixed in flexion. Pain on flexion. No abduction or adduction. Flexion contracture of 30°, bilateral	Ankylosis of lumbar spine and sacroiliac joint. Peripheral joints negative	Moderate	Extent 2 Severity 3 Incap. 50%	Yes
E. D. F57	4	8	Bilateral	Pain, swelling, limitation of motion	Pain, heat, limitation of motion, especially internal and external rotation	Hands, wrists, elbows, shoulders, knees, feet	Marked with partial disintegration of femoral heads	Extent 3 Severity 2-3 Incap. 70%	No
I. C. M68	25	26	Bilateral	Pain, marked limitation of motion	75% of normal range of motion	Entire spine, hands, knees	Moderate with mushroomed femoral heads	Extent 4 Severity 4 Incap. 80%	Yes
A. N. F38 (N. Y. Hosp.)	..	9	Right	Pain, limitation of motion	Data not available	Hands, elbows, knees, ankles, feet	Slight	Extent 3 Severity 4 Incap. 80%	No

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Arthritic symptoms had been present from eight to twenty-six years of age with an average duration of 13.5 years. The patients' ages at the most recent admission ranged from thirty-eight to sixty-eight years, with an average of fifty-four. It would seem that acetabular protrusion favors cases of long standing disease in the older age group, although our series is small.

We have found an incidence of 5 per cent (5 cases in 100) of protrusio acetabuli in rheumatoid arthritis of one or both hips. There is apparently no similar series in the literature available for comparison. Those series which deal with "incidence figures" have to do with the number of cases of protrusio due to rheumatoid disease in a series of all types of protrusio. Thus, Pomeranz found 16 per cent of secondary protrusions to be a result of rheumatoid arthritis (6 out of 38). Golding found 1 case in 15 to be associated with rheumatoid involvement (7 per cent). Overgaard (4) reported 6 cases with rheumatoid disease in 44 instances of secondary protrusion (14 per cent). The figures are probably not important, particularly since there is no statistically significant sampling. What is important is the emphasis on the relationship of rheumatoid arthritis of the hip and protrusion of the acetabulum.

It is not surprising that acetabular protrusion occurs in rheumatoid disease of a hip. In considering the extent and frequency of the reflex osteoporosis (12) found in rheumatoid arthritis, we should expect protrusio fairly often in a weight-bearing joint such as the hip. We feel that minimal protrusions may frequently go undetected and it becomes the responsibility of the radiologist to alert all concerned to this finding in rheumatoid arthritis.

SUMMARY

A brief review of the literature concerning protrusio acetabuli is given. The causative factors are discussed and the symptoms and physical signs are noted. The roentgen diagnosis is emphasized. Five cases of acetabular protrusion were found in 100 patients with rheumatoid arthritis of one or both hips. A tabular summary of these cases, with a sixth observed elsewhere, is given. Two additional, personally observed cases without protocols are mentioned. Roentgen illustrations of 7 cases are included.

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NOTE: Since completion of this paper, 2 more cases of protrusio acetabuli associated with rheumatoid arthritis have been seen by one of the authors (H.G.J.) at Montefiore Hospital.

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SUMARIO

Protrusión de la Cavidad Cotiloidea en la Artritis Reumatoidea

Repásase aquí la literatura relativa a la protrusión de la cavidad cotiloidea a la par que se describen las características clínicas y radiológicas. A fin de determinar la incidencia de este fenómeno en la artritis

reumatoidea de la cadera, se examinó a 100 enfermos que padecían de esta dolencia. En cinco de ellos se descubrió protrusión acetabular. Además se observaron 3 casos provenientes de otras partes.

A base de esta serie, se ofrecen varias observaciones: (1) En contraposición a la protrusión primaria de la cavidad cotiloidea, estos casos no revelaron predilección para el sexo femenino. (2) La invasión bilateral y la unilateral acusaron la misma frecuencia. En todos los casos, la afección reumatoidea era de mucha duración (ocho a veintiséis años).

En vista de la extensión y la frecuencia de la osteoporosis refleja en la artritis reumatoidea, no parece extraña la protrusión acetabular. Opinan los AA. que pueden pasarse por alto frecuentemente las protrusiones mínimas y que es obligación del radiólogo poner sobre alerta a todos los interesados con respecto a este hallazgo en enfermos de artritis reumatoidea.



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Sclerosing Osteogenic Sarcomatosis

A Radiologic Entity¹

JOHN E. MOSELEY, M.D., and MURRAY H. BASS, M.D.

THERE HAVE been a few scattered case reports of multiple osteogenic sarcomas occurring simultaneously in numerous bones of the skeleton (1-6). A case of this type, with features unique in our experience, was recently seen in this hospital (Mt. Sinai, New York) and stimulated a review of the available literature. To our surprise, we discovered 3 cases showing radiographic features practically identical with those seen in our patient. These features are striking, bizarre, and easily recognizable. Multiple areas of dense new bone formation are present throughout the skeletal system. In the long and short tubular bones, the sclerotic process has a marked predilection for the metaphyses. There is similar involvement of the ribs, clavicles, numerous round and flat bones, the vertebrae, and several epiphyses. Areas of soft-tissue calcification may be evident. In some regions, the process is limited to the bone, while in others it perforates the cortex and extends into the subperiosteum or adjacent soft tissue.

All the patients were young persons whose bones were in an active stage of growth. Biopsies of the lesions showed them to be sclerosing osteogenic sarcomas. In no case could there be demonstrated any underlying disease which might predispose to sarcomatous change. No history of ingestion of any radioactive substance could be elicited.

The following case is reported because of the rarity of multiple osteogenic sarcomas and because the roentgen appearance is presumably characteristic for one form of the disease.

M. E., a 5-year-old white girl, was admitted to the hospital Dec. 25, 1952. She had been well until about six weeks prior to admission, when a



Fig. 1. Diagram showing distribution of lesions in the skeleton.

slight hesitation in her gait became apparent. She was given a shoe wedge by her family physician for a "gait disturbance." About three weeks later a hard, slightly tender swelling was noticed just inferior to the right knee. An x-ray examination made at that time was interpreted as showing a malignant tumor of the upper end of the tibia, and the child was referred to the hospital for biopsy.

The patient was in no acute distress and did not appear ill. She weighed 49 pounds. The temperature was 99.6°, pulse 110 and regular, blood pressure 116/70. The family history was essentially negative. The patient had suffered infantile eczema, occasional attacks of tonsillitis, and chicken pox at the age of one and one-half years. The physical

¹ From the Department of Radiology, The Mount Sinai Hospital, New York, Dr. Bernard S. Wolf, Director. Accepted for publication in January 1955.

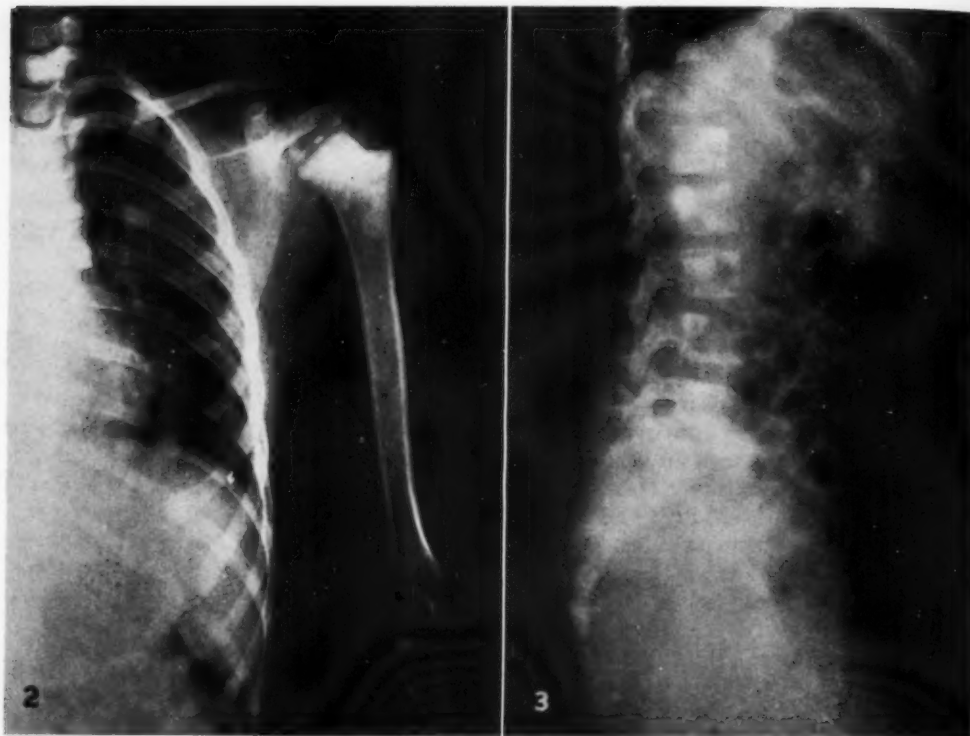


Fig. 2. Dense sclerotic lesion involving proximal metaphysis of left humerus. The process extends beyond the cortex into the subperiosteum. Note absence of involvement of epiphyseal plate. Small sclerotic foci also present in the medial condyle of the humerus. Sclerosing process at anterior ends of several ribs and involvement of first dorsal vertebra.

Fig. 3. Foci of sclerotic bone in several lumbar and sacral vertebrae.

examination was negative except for the skull and the findings at the right knee, where there was a ridge-like bony expansion of the upper tibia. This protruded anteriorly and to both sides 3 to 4 cm. inferior to the joint. About this area was moderate soft-tissue swelling, which was without discoloration, only slightly tender, but warm. There was no limitation of motion of the knee. The circumference at the involved site was 37.5 cm., as compared to 35 cm. at the same site on the left. No bruit could be heard over the mass and there were no pulsations. On the left side of the skull, in the parietal region, several small hard nodules could be palpated. They were firm and non-tender.

Laboratory examination revealed the following: red blood cells 4,680,000; hemoglobin 11.6 gm.; white blood cells 9,650. Sternal marrow aspiration findings were within normal range. There was no evidence of leukemia or neoplasm. The tuberculin test was negative. Blood calcium and phosphorus were normal. Alkaline phosphatase was 128 K-A. units; sedimentation rate 60 mm. in an hour.

Radiographic examination of the chest revealed no abnormalities of the heart or lungs. A skeletal

survey showed extremely dense sclerotic foci in the metaphyses of several long bones (Fig. 2, 6-9). The sclerotic process was sharply delimited by the epiphyseal lines. In some areas, it was contained within the bone, while in others it had perforated the cortex and extended into the subperiosteum. In the proximal half of the shaft of the right tibia, the process extended into the soft tissues and in some regions assumed a perpendicular striation (Fig. 8). Areas of sclerosis were also noted at the ends of numerous ribs, the right clavicle and acromion, and in several round and flat bones. The metaphyses of several short tubular bones in the hands and feet were similarly involved (Figs. 4 and 5). Noteworthy also was involvement of several epiphyses and numerous vertebrae (Fig. 3). In the skull, there was a small irregular area of sclerosis in the left frontoparietal region (Fig. 10). Soft-tissue calcifications were observed posterior to the right knee and in the posterior chest wall to the right of the bodies of the eleventh and twelfth dorsal vertebrae. An intravenous pyelogram disclosed no abnormalities of the upper urinary tract. Figure 1 shows the distribution of the lesions.

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Fig. 4. Sclerotic foci in several tarsal bones and similar involvement of the distal metaphyses of the second and fifth metatarsals of the left foot. There is early extension of the process beyond the shafts.

Fig. 5. Early sclerotic changes at proximal metaphyses of first metacarpal and proximal phalanx of fourth finger of left hand. The process is confined to the bone and limited by the cortex and the epiphyseal line. Sclerosis is also noted in the capitate and at the distal metaphyses of the radius and ulna.

Fig. 6. Sclerotic foci in bones of upper extremities. Small lesions at distal ends of humeri and in right capitulum. At distal right radial metaphysis, lesion extends beyond cortex but is sharply delimited by epiphyseal line. Small lesions in bones of left wrist and hand.



Fig. 7. Extensive and characteristic involvement of pelvis and upper femora. Note discrete foci adjacent to crests of iliac bones, dense involvement of femoral epiphyses, and lesions in pubis, ischium and sacrum.

Fig. 8. Massive involvement of upper right tibia. The sarcoma has extended well beyond the cortex and is invading soft tissue. Along its anterior and posterior borders there is a tendency for tumor bone to show perpendicular striation. Smaller lesions in epiphyses and in metaphysis of the femur. Calcific densities are present in the soft tissues posteriorly.

Biopsies were taken from the upper half of the right tibia and from the greater trochanter of the right femur. The pathological report of Dr.

Sadao Otani was as follows: "Lesion of trochanter: fragments of osteoid tissue with proliferation of osteoblasts; slight calcification of osteoid tissue;



Fig. 9. Sclerotic tumor foci in bones of left leg. In some areas, neoplastic tissue has extended subperiosteally.

areas of cartilaginous tissue also found; focal cellular areas suggestive of sarcomatous changes. *Lesion of tibia:* fragments of bone marrow spaces filled with osteoid tissue and areas of cellular proliferation with mitoses, suggesting sarcomatous changes. The soft tissue over the tibia was mainly fat tissue, but one vein was invaded by sarcomatous tissue."

Following the biopsies, the patient was discharged from the hospital. At home, new areas of bony involvement appeared in the temporal regions of the skull. The movement of the ocular muscles was affected and the pupils became dilated and failed to contract to light. Blindness developed, first in one eye and then in the other. The optic disks and maculae appeared normal. The child became gradually weaker and died on April 18, 1953.

COMMENT

Busso and Schajowicz (4), in Argentina, reported a case similar to this one in an eight-year-old girl. The roentgenograms



Fig. 10. Irregular, ill-defined area of sclerosis in left parietal region of skull.

showed sclerotic tumor foci in many of the bones, predominating in areas of most active bone growth. Halpert, Russo, and Hackney (5) described such a case in a seven-year-old girl, with roentgen findings almost identical to those observed by us and by Busso and Schajowicz. More recently, Lichtenstein (6) published similar roentgenograms of a boy fifteen years of age, which he regarded as probably representing multicentric osteogenic sarcoma. In the two former cases, biopsy and necropsy demonstrated the sarcomatous nature of the lesions. Lichtenstein does not refer to any pathological studies on his case.

In the case reported here and in that of Busso and Schajowicz, there was no roentgen evidence of pulmonary involvement. The cases reported by Halpert *et al.* and by Lichtenstein, however, showed numerous metastases in the lungs. The course of the disease in each instance was extremely rapid.

Several hypothetical explanations for the process are possible. The condition may be considered to be that of unusual osseous metastases from a solitary primary osteogenic sarcoma, with or without transpulmonary spread. It is also possible that the lesions represent primary sarcomas of multicentric origin. There is not, at present, any definite method of

distinguishing pathologically between primary osteogenic sarcoma and bone metastases from such lesions. The impression, therefore, of multicentricity must be based on the rapid appearance of similar tumors in numerous bones and predominantly in areas of bone which are characteristic locations for the origin of primary osteogenic sarcoma. Certain substances, such as radioactive elements and beryllium, may stimulate the production of bone sarcomas. It is possible, therefore, that multiple primary bone sarcomas, if they exist, may result from systemic irritants, known or unknown, which act on many parts of the skeleton simultaneously. Nor can one exclude the possibility of an inherent disorder of bone growth which results in malignant transformation at the site of new bone production. Whatever the etiology may eventually prove to be, we consider it more important, at present, to emphasize the appearance described above as representative of a special variety of multiple osteogenic sarcomas which may be said to constitute a radiologic entity.

SUMMARY

1. A case of sclerosing osteogenic sarcomatosis in a five-year-old girl is reported.

2. The radiographic appearance of the skeleton, striking and bizarre as it was, is almost identical with that seen in 3 other recorded cases and appears to represent a radiologic entity which can be easily recognized.

3. Possible etiologies for the disease are briefly discussed.

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SUMARIO

La Sarcomatosis Osteógena Esclerosante, Entidad Radiológica

Preséntase un caso de sarcomatosis osteógena esclerosante en una niña de cinco años, que tuvo un rápido desenlace letal. El notable y caprichoso aspecto radiográfico del esqueleto es casi idéntico al observado en otros 3 casos descritos y parece representar una entidad radiológica que cabe reconocer fácilmente. Consiste en múltiples zonas de densa neosteogenia por todo el sistema óseo, perforando en algunos casos la corteza y extendiéndose

hasta el subperiostio y aun los tejidos blandos.

Sugieren los AA. las siguientes como posibles causas de la dolencia: inusitadas metástasis óseas procedentes de un sarcoma osteógeno primario solitario, con o sin difusión transpulmonar; sarcomas primarios de origen multicéntrico; un trastorno inherente del desarrollo óseo que da por resultado una transformación maligna en el sitio de la neosteogenia.

The Care of the Patient with Advanced Cancer of the Breast¹

SIMEON T. CANTRIL, M.D.

THE PRACTICING physician, in whatever branch of medicine, encounters the problems of cancer of the breast. Although the phases of diagnosis and treatment differ, we all must be impressed by the magnitude of the overall morbidity. The stimulus to seek new approaches to therapy, or to make the most of present knowledge, stems from an appreciation of the courage and hope displayed by so many patients, often exceeding that of the physician.

Prognosis in cancer of the breast is largely determined by (a) the local and metastasizing potential of the growth, (b) the stage of pathologic spread when the patient is first seen, and (c) the applicability and effectiveness of initial and subsequent treatment. Therapy, therefore, is concerned with the choice of the agent best suited to the individual case, in view of the relative malignancy and extent of the disease. Current methods utilize surgery (with or without irradiation) in those patients deemed operable by certain standards which, in the larger centers, are becoming more uniform. If the disease is initially inoperable or reappears following surgery, the cancer will in most cases progress, after a widely varying interval, to a fatal termination. We have seen patients living remarkably symbiotic lives with cancer of the breast for two or more decades, while others succumb within a matter of months.

Our discussion here need not concern itself with the more fortunate minority who remain outside the domain of advanced cancer. For the larger and more unfortunate group, the problem is one of utilizing existing knowledge in a delaying action to retard the growth if possible, and to relieve the patient as best we can of the pain and debilitation of advancing disease.

This becomes a matter of experience and judgment in the use of supportive therapy, irradiation, or alteration of hormonal balance, at such times as these will be most effective for the longest period. Thus far, all of these procedures seem self-limited in action, producing a varying period of retardation. It must be remembered, also, that the natural barriers of the host may be upset by excessively rigorous measures applied at the wrong time.

Before considering specific measures at our disposal, it is well to remind ourselves that we are dealing with a patient as well as a disease. In an association which may last for a number of years, it is necessary to have her confidence and her realization that the physician is interested in her problems and will be sympathetic to her fears as well as to her pains, that he will not abandon her, and with his colleagues will do everything possible to see her through an ordeal which, in the majority of instances, she foresees without his emphasizing the outlook. This patient-physician relationship may be as important as anything we do. In some instances it is all we succeed in doing.

Though we are still powerless to stop the progress of the disease when it has exceeded regional bounds, knowledge is accumulating which, if wisely used, may prolong in greater comfort the life span of those with advanced breast cancer.

In attempting to delineate where "advanced" begins, one recalls first the progressive disease following surgery, presenting as either local or regional cancer, with or without demonstrable evidence of distant spread. Another large group is composed of neglected cases inoperable by present criteria. A smaller group consists of the rapidly fulminating cancers, seemingly advanced from the beginning. Path-

¹ From the Tumor Institute of the Swedish Hospital, Seattle, Wash. Presented at the Fortieth Annual Meeting of the Radiological Society of North America, Los Angeles, Calif., Dec. 5-10, 1954.

biologic spread may have little relationship to time of discovery or promptness of treatment. Current propaganda relating to early diagnosis and treatment should not be discouraged, yet we must realistically admit that the time element is of less importance to the patient than the type of cancer. No amount of education can influence the biologic potential to early spread.

In any large group of women seen with breast cancer of *all stages*, in which our present complete armamentarium is employed according to current standards of operability, local irradiation, castration, or hormonal therapy, some 35 to 45 per cent will survive for five years and perhaps not more than 15 to 20 per cent for ten years. The pertinent question is: At what stage in their medical observation did the majority of patients enter the advanced group to end as failures? The only possible answer is that in all the disease was advanced when first seen and before any treatment was undertaken.

Of all breast cancer patients examined in larger centers, some 60 to 75 per cent are considered operable and are treated by radical mastectomy. The operation, as first designed by Halsted, had as its intent the reduction of the high incidence of local residual disease appearing over the chest wall. Present rates for this complication, with more stringent selection of patients, are of the order of 10 to 15 per cent. This feature of radical mastectomy has, however, been subordinated to eradication of axillary spread. Of the patients subjected to radical mastectomy, about 60 per cent will show evidence of axillary metastases on careful examination of all lymph nodes removed. Of this latter number, about one-third will survive five years, and one-quarter ten years. The remaining two-thirds are unrecognizably inoperable or advanced, since radical surgery does not arrest the disease. Of the total patients receiving radical mastectomy, about 1 in 5 survives five years because of the axillary dissection. As Smithers (1) has pointed out: "The evidence is clear that radical

mastectomy has its greatest success in cases where the pathologist is unable to find axillary involvement for which the operation was performed, but it is this success which is always put forth as a justification."

To salvage one-third of the patients may well justify radical mastectomy in all, but one asks how the latent advancement in the failures could have been judged beforehand, possibly forestalling a radical operation doomed to failure at the outset. Handley (2) of Middlesex Hospital, London, and Hutchinson (3) of Swedish Hospital, Seattle, have made important contributions to the recognition of latent but advanced breast cancer. Hutchinson's larger series comprises 81 consecutive radical mastectomies. All patients were likewise subjected to diagnostic exploration of the internal mammary chain on the affected side in an attempt to determine the degree of spread. One-half of the 81 patients had metastases only to the axillary lymph nodes. In 19 patients (23 per cent) the disease had spread to both the axillary and internal mammary chains. Of Handley's 50 patients, 16 (32 per cent) showed axillary as well as internal mammary spread. Equally significant is the outcome in Hutchinson's 19 cases with axillary and internal mammary spread: At the end of three years 17 patients were either dead or living with distant metastases, while only 2 were well and without evidence of distant metastases, but for a maximum period of only four years. These 19 patients, representing 25 per cent of those subjected to radical mastectomy, had advanced cancer at the time of surgery. Furthermore, they represent only one of several hidden avenues of metastatic spread currently unrecognizable by careful preoperative clinical and radiographic examinations.

McWhirter's classic experiment, recently reported (4), suggests again that 1 in 4 patients of the operable group will have metastatic lymph nodes confined to the axilla, whereas 35 per cent of those with axillary metastases, in the clinically oper-

able group, will also have spread to the supraclavicular or internal mammary chains. This analysis, together with the surgical studies briefly described, indicates that operability by radical mastectomy is applicable to about 35 per cent of any large group when all cases are considered. If patients without axillary metastases are excluded, then the operation had a chance to improve the prognosis in not more than 15 per cent of all cases. Johnson (5), in a critical analysis of the measurement of effect of treatment in breast cancer, suggests that the rate at which deaths occur may be a better index of therapeutic effect than survival statistics. In significantly large groups in which all cases examined are included, the deletion of deaths occurring within the first two years after treatment and presumed to be due to either advanced or fulminating disease, eliminates those in whom any treatment would be ineffective. It is of interest that, when all cases in one center in which radical surgery is predominant are compared with McWhirter's results, the death rate in the third, fourth, and fifth years is not significantly different. These studies indicate that there is increasing awareness of the need for more attention to possible latent advancement of the disease when the patient is first seen, and that this emphasis may give to irradiation or measures other than surgery a greater role in treatment.

The question now arises: What can we do for the patients who are not accepted for radical operation? Are they to be left untreated by any surgical means? What has irradiation to offer them, either alone or combined with less radical surgery? Our limited experience, in recent years, of collaborating with the surgeon in performing simple mastectomy and irradiating the internal mammary chains, axilla, and lower neck in patients with demonstrated internal mammary spread, does not indicate that eventual distant metastasis of the disease is favorably influenced. The patient has, however, been spared a useless radical mastectomy. The risk of further dissemination entailed in any radical opera-

tion has been lessened, and the reserve strength of the patient has been spared. These in themselves are not entirely negative contributions to the patient's welfare.

IRRADIATION IN THE TREATMENT OF ADVANCED CANCER OF THE BREAST

The result of irradiation in advanced breast cancer is greatly influenced by the age of the patient, rapidity of growth and cellular activity of the lesion, and the amount of fibrotic reaction already present, as well as other, more subtle influences. For purposes of our present discussion, we may generalize by observing that: (a) External irradiation to primary cancer of the breast or its regional lymphatic spread is capable of producing clinical regression and at times disappearance of palpable tumor. The degree of response is to a considerable extent dependent upon dose, but, even when protraction carries the radiation within the breast and regional lymphatics to maximum tolerable limits, the ultimate effects are more often palliative and rarely curative. (b) Irradiation to extramammary sites is adversely influenced by pathologic anatomic considerations which rarely permit achievement of maximum dose levels that even in the breast serve only to retard the growth. Whenever the cancer spreads to vital organs, dose is limited to less than that which can be safely employed in the breast itself. These limitations may exclude irradiation as an effective palliative agent, as in lung metastases. Yet in metastases to bone a palliative response (relief of pain and/or restitution of structure) may be obtained with a dose only a fraction of that required to cause regression of the same cancer in the breast itself. (c) There is thus a wide latitude of response to irradiation dependent upon factors which can be included in the term "environmental." It is this wide range of dose-response that enables irradiation to have an effective role in palliation. (d) Experience indicates the wider categories of spread in which irradiation may be useful. Yet within these categories, clinical trial is always safer

than prediction whether irradiation will accomplish palliation. There is no way to foresee in a given patient whether irradiation will alleviate bone pain or retard osteolysis other than to use it and observe the result. We have at times used x-ray therapy to reduce a large and painful metastatic liver or other intra-abdominal spread when the general condition of the patient has otherwise been reasonably good. Such therapy is well tolerated and may be effectively palliative.

Irradiation of the inoperable breast is a problem frequently encountered. It is a procedure of sufficient magnitude that the patient's age, general condition, and relative freedom from important distant spread all must be appraised in relation to the anticipated palliation. In general, the procedure includes irradiation of regional lymphatic spread, thus requiring multiple fields of considerable extent. An adequate clinical trial will require minimum protraction of some six to eight weeks, and even so the reactions may be considerable. Avoidance of pulmonary reaction requires oblique tangential fields. Lenz (6) and Baclesse (7), using long protraction, have found external irradiation alone effective in achieving long-term primary palliation. In the group reported by Baclesse, when protraction was extended for as long as twelve to sixteen weeks, 38 of 109 patients (34 per cent) survived and were clinically well for five years. Unless one is personally familiar with the meticulous care given by Baclesse to each of his patients throughout treatment, it is difficult to appreciate the scope and accomplishment of his work. Lenz, after observations extending over ten years on patients receiving irradiation alone, concludes that the method is capable of producing long retardation of growth within the breast, though the patient may succumb later to distant metastases. If irradiation alone is to achieve optimum palliation, the important factor is long protraction, permitting a dose within the breast and regional lymphatics of 5,000 to 6,000 r minimum, without unsupportable

early reactions which force cessation of irradiation or later produce local necrosis or pulmonary fibrosis, offsetting the benefits of the procedure.

The same principles apply to the treatment of inflammatory cancer of the breast, except that this type is even more discouraging. In our experience, important distant metastases are often encountered even before treatment is concluded or within several months thereafter.

Irradiation of postsurgical regional spread is a problem encountered before more generalized metastases reduce the relative significance of regional cutaneous or lymphatic permeation.

We have all seen the skin manifestations of residual disease at the operative site which may first appear in or near the scar as small nodules only. Looking at these from the surface, we may fail to appreciate that those which become visible or palpable are outcroppings of a more diffuse subcutaneous lymphatic spread. If one adhered to the strict pathologic anatomy of the process, treatment of the entire affected chest wall, including the parietal pleura, would be the only logical approach. This is obviously impractical with an effective dose. We must therefore compromise, treating individual or contiguous groups of metastases with low-voltage irradiation such that a dose of 4,000 to 5,000 r can be given in a period of a week or less, depending upon the volume to be irradiated. Low voltage (120 kv) is used to reduce the dose to underlying lung. Such therapy for the smaller clusters of cutaneous nodules may be effective for a considerable period until more generalized metastases assume priority or wider evidence of chest wall spread appears. There are a few patients in whom the disease may remain limited to the operative site for many years, with local irradiation only.

Massive cutaneous manifestations are usually most difficult to control by any method, including irradiation. Radical surgery, with removal of segments of the thorax, was undertaken as a possible control measure some years ago, but was

found even more futile than irradiation and was subsequently abandoned. The larger, solitary ulcerations over the chest wall are more worthy of a serious attempt to promote healing by external irradiation. These are commonly associated with some degree of involvement of underlying bone. Widely scattered multiple nodules are more distressing to the patient because of their ulceration and visible evidence of cancer than are more distant metastases hidden in vital organs. Wide tangential fields are the only approach, with protraction carrying the dose to levels which can be determined only by close observation. Failure has been more common than local healing and hormonal therapy is now considered a simpler and more effective agent than irradiation.

Irradiation for the control of pain from bone metastases is possibly the radiologist's most significant contribution to the management of carcinoma of the breast. Skeletal pain without radiographic evidence of metastasis is no reason to withhold irradiation, since this has its greatest effect in early skeletal involvement.

In addition to the aim of pain relief is the desire to retain bone structure in weight-bearing parts of the skeleton and to avoid pathologic fracture. In the ambulatory patient with any evidence of skeletal involvement it is well to examine the spine, pelvis, and lower extremities even in the absence of symptoms. Irradiation of an impending fracture may spare the patient a crippling disorder.

Apart from radiographic skeletal surveys, the recent work of Pearson and co-workers (8) at the Memorial Center indicates the value of urinary calcium excretion determinations as a measure of the osteolytic activity in progress. Analyses are relatively simple and can serve as a guide to efficacy of the treatment and the progress of skeletal disease.

There are two interrelated aspects of the problem of skeletal spread. One concerns the level of an effective dose of irradiation. The other is the presence of widespread bone metastases.

The matter of dosage in bone metastases from breast cancer presents an ironic yet fortunate situation. A relatively small dose—one without comparable effect in the breast itself, metastatic lymph nodes, or skin—may relieve pain or even promote bone healing. There is no one order of magnitude of dose for these metastases. Treatment is best adapted to the individual situation. In the patient with solitary or limited involvement, we would use a smaller dose (1,000 to 1,500 r in bone) when treating for pain in a non-weight-bearing bone than when irradiating a weight-bearing structure, where the problem concerns both pain and disability. Here the dose may be as high as 2,000 to 3,000 r in two to three weeks.

It is necessary to follow the progress of some patients by later radiographic examinations. Evidence of bone reconstruction is not so consistent as is relief of pain. In certain instances we have been unable to accomplish any palliation of bone metastases by external irradiation. Yet it is our observation that, of all the agents utilized for the treatment of skeletal metastases, x-ray therapy will help a greater number of patients for a longer period.

Widespread skeletal metastases in the patient who is still ambulatory are a particularly distressing problem. Here we would choose to combine some form of hormonal therapy (castration or hormonal medication) with irradiation of limited areas where pathologic fracture may appear imminent.

Friedell and Storaasli (9) and later J. R. and G. S. Maxfield (10) described favorable results with radiophosphorus in bone metastases. Friedell, whose approach is conservative from the standpoint of selection of patients, points out that the treatment is rigorous and to be considered only in the presence of widespread involvement and severe bone pain. Objective evidence of bone regeneration did not occur in more than 15 per cent of his patients. The dose of P^{32} was influenced by hematopoietic depression as manifested by petechiae or

hemorrhage. Total doses were of the order of 20 mc—rarely as low as 15 mc—given in increments of 2 mc over forty or more days. Since Maxfield combined the use of P^{32} with castration and testosterone, the specific action of the isotope could not be assessed in all of his patients. About 10 mc was given in divided doses of 1.5 mc per week. Whatever the *modus operandi*, some of Maxfield's results are impressive. In a group of 15 patients to whom we have applied these procedures, we have, to date, evidence of bone healing in 1.

The use of radiogold and radiochromic phosphate for reducing pleural effusion of metastatic origin is sufficiently well established to deserve a trial in patients who require frequent thoracenteses. In our experience, cases in which reduction or complete suppression of fluid re-formation was not achieved by this method have been fewer than those in which it was helpful. When the thorax has been found, on aspiration, to contain frank blood, the radioactive material has not plated out on the pleural surfaces and no improvement has been obtained. We have used comparable procedures in ascites from breast metastases, with satisfactory palliation, when the general condition and life expectancy of the patient warranted their use.

Pain from metastatic breast cancer may be alleviated by methods other than irradiation or hormonal therapy. These may be both simple and lastingly effective. I refer to the help which we may elicit from the neurosurgeon or anesthesiologist skilled in regional infiltrative anesthesia. We would do our patients a service by seeking the active collaboration of a physician adept in regional anesthesia and affording him an opportunity to share more actively with us this problem of refractory pain.

HORMONAL THERAPY

The most significant progress in understanding cancer of the breast has been made through studies of hormonal influences which may control tumor growth. Apart from the effectiveness of ovarian

castration, demonstrated in the last century, androgenic and estrogenic medication and, more recently, adrenalectomy and cortisone are powerful palliative agents. Because they are not totally effective in arresting breast cancer, we may tend to underestimate their importance.

The growth-retarding influence of ovarian castration in mammary cancer may be useful in the premenopausal and menopausal age. In some postmenopausal women, also, there is evidence to indicate continued ovarian secretion of estrogen in significant amounts for as long as ten or more years after cessation of the menses. The important decisions concern (a) the selection of patients for this procedure; (b) judgment of the time after appearance of metastases when it should be undertaken, (c) evaluation of its effects.

There are no clear clinical grounds from which one can foretell the effect of castration. Nor is the quantitative level of estrogen excretion throughout the menstrual cycle a guide to selection of patients. Pearson and co-workers (8) have shown the value of urinary calcium excretion data as an objective guide to the effect of suppression of estrogen secretion by surgical castration in patients with osteolytic metastases. They have also followed calcium excretion in such patients throughout a menstrual cycle prior to castration and note that a wide fluctuation occurs in those who, on subsequent castration, exhibit a lowered calcium excretion and a favorable response on the part of osteolytic metastases. In patients whose calcium excretion remained high throughout the cycle, castration did not retard the osteolytic process. Here then is a relatively simple and quantitative measurement of effect of ovarian castration on one common manifestation of advanced disease, osteolytic metastases. It is reasonable to argue that, if the cancer is retarded in bone, it is simultaneously retarded elsewhere in this so-called "estrogen-dependent" group. In patients with osteolytic metastases and high calcium excretion, who have a cancer in which estrogen is an important growth-

maintaining agent, the objective evidence of falling calcium excretion following castration is an early guide to what can be expected from the procedure.

The crux of the matter lies in determining when castration is indicated. There are those who advocate its performance in all patients with mammary cancer in the premenopausal age regardless of extent of disease. This we feel is a lavish spending of a valuable resource which may later be required. Thayssen (11), from the Radium Center of Copenhagen, considers the effect of roentgen castration for metastatic disease on survival. His study indicates a significantly longer survival period in the castrated group as compared with a non-castrated group of similar age. He concludes, however, that this longer survival depends upon careful timing of the castration. In general, observations in the estrogen-dependent group indicate that improvement following castration is for the most part only temporary, being usually measured in months. The rare occurrence of longer periods of palliation cannot be foretold. One has to decide when to spend the profitable margin from castration in the best interest of the patient. Once used, it cannot be repeated. Our own experience has led us to withhold castration in patients with limited metastases in the soft parts or bone which can be satisfactorily palliated by irradiation. When metastases are more widespread or when irradiation and/or androgens are not effective, castration is then recommended. Anticipating that the benefits will at best be temporary, we use it late in the disease, after the usefulness of irradiation for limited metastases has been exhausted.

Indications for castration in the menopausal and early postmenopausal group are not dissimilar to those in the premenopausal age. It may be that we do not give sufficient consideration to its potentialities in these women in whom it involves less physiologic and psychologic disturbance than in patients of the younger age group.

If castration is to be performed, what

are the relative merits of surgery and irradiation? If the latter is used, how large a dose is required? There can be no argument that surgical castration eliminates ovarian function more promptly and with greater certainty. Its only deterrent is the requirement of laparotomy. X-ray castration is relatively easy for the patient but is often incomplete because of inadequacy of dose and the reliance upon amenorrhea as the sole guide. We actually have no established data on the completeness of estrogen suppression by roentgen castration in relation to dose and age. For this reason, and preferring to err on the side of increased dosage, we have adopted a policy of delivering a minimum of 1,200 to 1,500 r to the ovaries in about ten to fourteen days.

The action of androgens in therapy of metastatic disease must somehow be correlated with their anti-estrogenic effect. Experience indicates that if the patient is to benefit from androgens, some two to three months of administration will be required for an adequate clinical trial. Here, as with castration, any improvement obtained lasts for a limited period only, and the effect is then lost. Hence we have withheld androgens in the premenopausal and menopausal age until the disease has advanced beyond the reasonable use of irradiation for limited metastatic deposits in the soft parts or bone. Formerly in certain cases we used androgens prior to castration, with sufficient benefit in some instances to justify this sequence. In general, it would seem more reasonable to perform castration than to resort to androgens without prior elimination of ovarian function. The real role of androgens and their method of action remains a puzzle.

Estrogenic medication, with its powerful effects, provides a most useful agent for many elderly patients in whom either surgery or massive irradiation is contraindicated or would require a major effort. In our experience its benefits in causing regression of soft-part disease are more constant and longer lasting than are those of andro-

gens in the premenopausal or menopausal group. Patients may be maintained on minimal doses of estrogen for many months without toxicity. In our elderly patients this takes precedence over all other methods of therapy, being attended by less morbidity and greater palliation than more rigorous procedures.

Both cortisone and adrenalectomy have demonstrated their value in patients who have become resistant to other procedures. The problems of adrenalectomy revolve about the proper selection of patients and the time at which the procedure should be performed. It appears to have been established that those patients who respond well to castration are the ones who may possibly benefit by adrenalectomy. At present this seems to be the last card which we hold; yet it cannot be withheld too long. As radiologists we need to learn more about this procedure, so that we may properly evaluate it and advise patients who may benefit by it.

ANALGESICS AND SUPPORTIVE THERAPY

Irradiation, hormonal therapy, and regional anesthesia will not eliminate the need for analgesic drugs at some time in the course of mammary carcinoma. This important aspect of total management is all too often left to chance or the divided responsibility of several physicians. If the radiologist assumes the care of the patient, then it rests with him to direct whatever medication is required. Otherwise he should keep closely informed by his colleagues.

The general principle in the use of analgesics is to give enough for relief of pain. Patients frequently have a fear of addiction which can be overcome only by the assurance of the physician that this is his responsibility and that the drugs prescribed are for use as directed. The specific drugs used may not be so important as experience with a limited number of analgesics of varying potency and true acquaintance with their use and effectiveness. Drug therapy, however, like irradiation, requires personal supervision and reap-

praisal, and the dose needs to be adjusted to the individual problem of pain.

Other measures may add to the patient's comfort and well-being. Attention to anemia and the use of blood are indicated more often than we realize in a disease in which there is not blood loss but a real failure of blood formation, and in patients undergoing irradiation of hematopoietic tissues over long periods. Supportive appliances in the presence of vertebral metastases are many times more helpful than maintenance of posture by muscle spasm. Attention to matters of diet and rest cannot always be left to the patient. Many of these factors will not be brought to the physician's attention unless he has time to discuss with the patient the problems which must pass through her mind and are accepted by her as something to be endured.

One may ask when the disease may be considered to have entered a terminal phase in which supportive and analgesic therapy alone are applicable. There is no one answer to this query, since the response to more active measures will vary from case to case. Certainly we have all seen patients who have lived long and in relative comfort following irradiation and hormonal therapy, as though natural barriers to the lethality of the disease had arisen in contrast with our more feeble and ineffectual efforts. The physician is indeed overestimating his power of healing if he considers that the terminal phase invariably begins when he has exhausted his resources. In cancer of the breast the finality of "terminal" is difficult to judge and can in most patients be applied only when signs of the impending end appear. To each of us "terminal" may have a different meaning, and in a disease with so wide a range of malignancy as cancer of the breast this is understandable. Regardless of our individual definition, however, it is our responsibility to employ all the methods at our disposal to see that the patient passes through this final zone with the least discomfort and apprehension possible.

SUMMARY

Radiologists should approach the problem of advanced cancer of the breast with a view to using the available methods of treatment at the time when each is most needed, with recognition that the requirements of individual patients vary. It is possible, as concepts change, that irradiation may come to play a greater role than at present, yet its limitations must be recognized without losing sight of its potentialities for effective palliation. Cancer of the breast, in frequency, magnitude, and complexity of growth, requires a planned rather than haphazard application of known methods of treatment. At the present time, this is the basis of sound palliative therapy.

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SUMARIO

La Asistencia de la Enferma con Cáncer Avanzado de la Mama

Los radiólogos deben abordar el problema del cáncer avanzado de la mama con mira a utilizar los métodos disponibles de tratamiento cuando más se necesita cada uno de ellos y reconociendo que varían los requisitos de cada enferma. Los procedimientos paliativos pueden comprender la mastectomía radical o la simple y la irradiación además de la cirugía o sin ésta. Se presta consideración al empleo de la irradiación para el dominio del dolor causado por las metástasis óseas y con el propósito

de retener la estructura ósea en las partes del esqueleto que soportan el peso y de evitar posibles fracturas patológicas. Se avalora la hormonoterapia, es decir, la castración así como la medicación hormonal y se discute la misión de los analgésicos y de la terapéutica fortaleciente. Señálase que el cáncer puede ser ya "avanzado" desde el momento en que se descubre. Recálcense la individualización del tratamiento y la importancia de la relación entre doctor y enfermo.

The Dosimetry of Beta Sources in Tissue.

The Point-Source Function¹

ROBERT LOEVINGER, Ph.D.

THE WIDESPREAD use in medicine and biology of radioactive nuclides emitting beta particles has focused attention on the problem of the dose distribution in tissue corresponding to non-uniform distributions of the radioactivity. The problem has two aspects. First, the distribution of absorbed energy (*i.e.*, dose) about a point source of beta particles must be inferred in some fashion. Second, this point-source energy-distribution function must be integrated over some distributed source, real or hypothetical, to get the dose distribution. For purposes of radiation dosimetry, it would clearly be convenient if the point-source distribution could be described by a reasonably simple mathematical function. The purpose of this paper is first to present such a function, then to indicate the extent to which this function fits available experimental data, and last to discuss the application of this function to beta sources distributed in tissue.

Experimentally, the problem has been approached in two ways, indirect and direct. The first experimental work was done with the *indirect* method (5), which consisted in attempts to deduce the point-source distribution function from the appropriate mathematical manipulation of measurements made on plane sources in polystyrene. Some of the results by this method have already been reported (6). The *direct* experimental approach consists in measurements on point sources of beta particles in air. Such measurements have been made by Sommermeyer and Waechter in Germany (10, 11), Clark, Brar, and Marinelli in Chicago (1), and Emery in England (2). The data from these three sets of observers give a relatively complete and consistent picture of the point-source distribution in air.

When representing the experimental \bar{E} is the average beta-particle energy per

data with a function for dosimetry purposes, it is quite satisfactory to account for 90 or 95 per cent of the energy, with reasonable accuracy. The remainder of the energy, distributed over the last quarter or third of the beta-particle range, will, in general, be of little biological significance. This allows the function to be run to infinity, which greatly simplifies the mathematics. The measurements on point beta-particle sources in air can be represented, with this degree of accuracy, by the following function:

$$x^2 I(x) \propto [x_1 - x e^{1-(x/x_1)}]_1 + [x e^{1-\mu x}]_2 \quad (1)$$

[]₁ $\equiv 0, x \geq x_1$

This can be somewhat more conveniently written in terms of the dimensionless variable $r = \mu x$, and $c = \mu x_1$. Then Equation 1 becomes

$$r^2 I = k \{ [c - r e^{1-(r/c)}]_1 + [r e^{1-r}]_2 \} \quad (2)$$

[]₁ $\equiv 0, r \geq c$

Now I is the point-source distribution function, that is, the absorbed energy per gram per disintegration, at a distance $r = \mu x$ from a point source of beta particles. μ is the apparent absorption coefficient, properly so called because, if this equation is integrated over a plane source of any thickness, it predicts exponential attenuation with an apparent absorption coefficient μ . The parameter c gives the value of the first square bracket at $r = 0$, and also the value of r at which the bracket vanishes. The bracket is taken as identically zero for all r greater than c . The normalizing constant k is evaluated by the requirement that $r^2 I$ integrated over all space must equal the average energy per disintegration, which gives

$$k = \frac{\mu^3 \bar{E} \rho_m^2}{400\pi [c^3(3 - e) + e]} \text{ rad} \quad (3)$$

¹ From the Andre Meyer Department of Physics, The Mt. Sinai Hospital, New York, N. Y. Presented at the Fortieth Annual Meeting of the Radiological Society of North America, Los Angeles, Calif., Dec. 5-10, 1954.

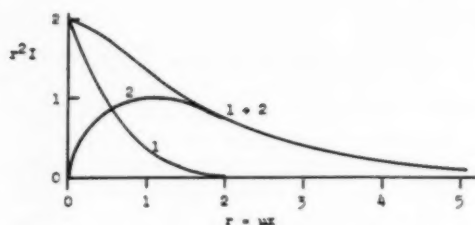


Fig. 1. Illustration of the two-parameter function r^2I , Equation 2, for $c = 2$.

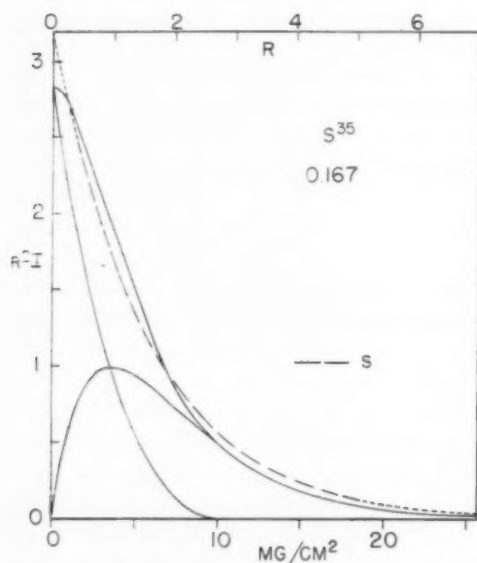


Fig. 2. Comparison of experimental data and computed distribution of energy for point source of beta particles in air, S^{35} . See text.

disintegration in ergs, μ is the apparent absorption coefficient in cm^2/gm , ρ_m is the density of the absorbing material in gm/cm^3 , and the unit of absorbed energy is 1 rad = 100 ergs/gm.

Figure 1 illustrates the general nature of Equation 2, showing the two brackets and their sum, for $c = 2$.

This function was arrived at empirically. Its justification is that it represents the data. It can, however, be argued that the two brackets in Equations 1 and 2 represent two components of the beta particles. The first bracket appears to represent the energy absorbed from a primary, essentially unscattered component of the beta particles.

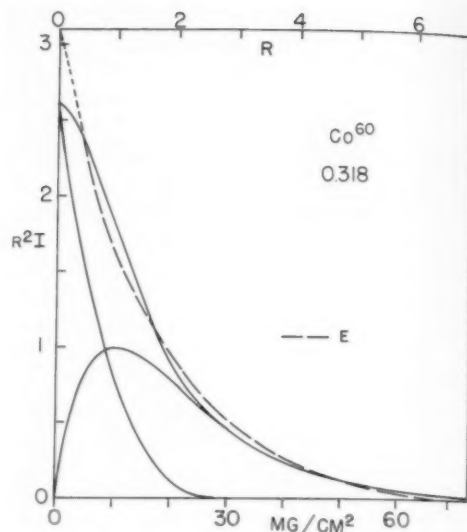


Fig. 3. Comparison of experimental data and computed distribution of energy for point source of beta particles in air, Co^{60} . See text.

Bracket sub 2 appears to represent the energy absorbed from a secondary, scattered component of the beta particles. The geometrical inverse square attenuation is, of course, represented by the r^2 term on the left. The right side of the equations represents attenuation due to energy loss, and should vanish at the maximum beta-particle range. It will be seen that the value of the second bracket is so small at the end of the range as to be negligible for purposes of dosimetry.

This function has been found to fit the point-source data in air using values of the parameters computed from the following formulae:

$$\mu = \frac{16.0}{(E_0 - 0.036)^{1.40}} \left(2 - \frac{E}{E^*} \right) \text{ cm}^2/\text{gm. of air} \quad (4)$$

$$c = 3.11e^{-0.56E_0} \quad (5)$$

E_0 is the maximum energy of the beta-particle spectrum in Mev. E is the actual average energy per disintegration, and E^* is a hypothetical average energy per disintegration for a hypothetical allowed spectrum of the same maximum energy. For allowed spectra, the ratio E/E^* is unity, and the bracket containing this ratio is

unity. For most of the forbidden spectra, the ratio is within a few per cent of unity. But for RaE and Sr⁹⁰, \bar{E}/\bar{E}^* has the value 0.77 and 1.17, respectively. Evidently the average energy of the RaE spectrum is about 25 per cent softer, and of the Sr⁹⁰ spectrum about 15 per cent harder, than

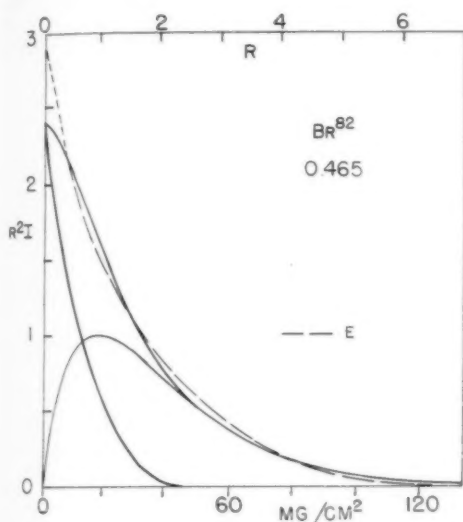


Fig. 4. Comparison of experimental data and computed distribution of energy for point source of beta particles in air, Br⁸². See text.

the average energy of a corresponding (hypothetical) allowed spectrum. Introducing the factor $(2 - \bar{E}/\bar{E}^*)$ serves to bring RaE and Sr⁹⁰ into the same generalization as the other radionuclides.

It will be noted that μ and c are functions only of the maximum beta-particle energy E_0 and of the distortion of the spectrum from an allowed shape. In Figures 2 to 13, there has been no individual adjustment of the parameters μ and c , which have in all cases been computed from the empirical Equations 4 and 5.

On each of the Figures 2 to 13, the symbol of the radionuclide is shown, and under it the maximum beta-particle energy in Mev. The ordinates for the computed curves are r^2I . These curves are computed from Equation 2, taking $k = 1$ for graphical purposes, and are shown as solid lines in the figures. The two brackets and the

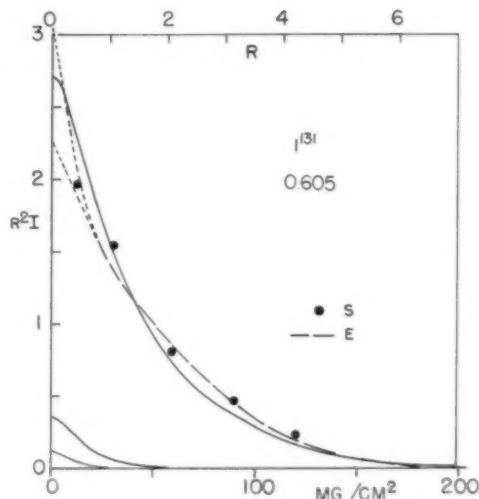


Fig. 5. Comparison of experimental data and computed distribution of energy for point source of beta particles in air, I¹³¹. See text.

sum are shown for all except the compound spectra, for which only the sum is shown for each component. The lower scale of abscissae is the distance x from the point source, in mg./cm.² of air. The upper scale of abscissae is the dimensionless distance $r = \mu x$. The experimental curves are either normalized to equal area with the computed curve, or the points adjusted to the best fit by a multiplicative constant, as indicated below. The source of the experimental data is shown on each figure as follows: E for Emery (2); CBM for Clark, Brar, and Marinelli (1); S for Sommermeyer (11); and SW for Sommermeyer and Waechter (10). Since Emery gives his results in terms of smoothed data, they are presented in these figures as a broken curve instead of observational points. These curves are shown on a linear (rather than a semi-log) plot, in order to indicate correctly to the eye the relative amounts of absorbed energy as a function of distance. The product r^2I is proportional to the energy absorbed in a thin spherical shell of radius r .

Figure 2, S³⁵, $E_0 = 0.167$ Mev, $\bar{E}/\bar{E}^* = 1$: Sommermeyer measured S³⁵ in air on various supports, extrapolating to the atomic number of air. Thus he

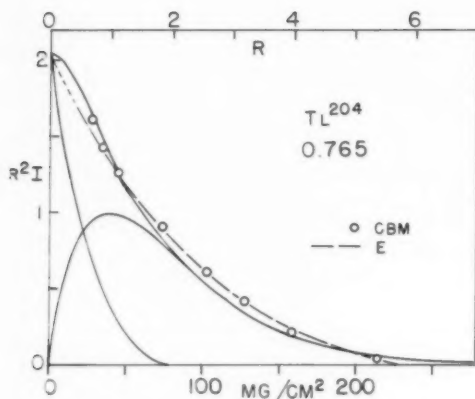


Fig. 6. Comparison of experimental data and computed distribution of energy for point source of beta particles in air, Tl^{204} . See text.

inferred an exponential function in air, from about 1.2 to 19 mg./cm². The broken line indicates the region covered by his observations, the short dashes are an extrapolation based on the assumption that the entire curve is exponential. This extrapolated exponential has been normalized to equal area with the computed curve. It is not clear whether it would have been possible to observe the difference between the two curves over the region covered by his observations.

Figure 3, Co^{60} , $E_0=0.318$, $E/E^*=1$: Emery's curve is essentially exponential but is fairly well represented by the computed curve. The short dashes represent what is apparently an extrapolated region in his results. Curves normalized to equal area.

Figure 4, Br^{82} , $E_0=0.465$, $E/E^*=1$ (probably): Emery's data, shown as extrapolated by him to zero distance. Curves normalized to equal area.

Figure 5, I^{131} , $E_0 = 0.605$ (86 per cent), 0.335 (10 per cent), 0.250 (3 per cent), and 0.807 (1 per cent); $E/E^* = 1$ (probably): The figure gives the observations of Sommermeyer and Waechter and the smoothed data of Emery. Emery gives two alternative extrapolations to zero distance, both of which are shown. Experimental results adjusted to best apparent fit with each other and with the computed curve.

Figure 6, Tl^{204} , $E_0 = 0.765$, $E/E^* = 0.99$: Experimental results normalized to equal area with the computed.

Figure 7, Au^{198} , $E_0 = 0.958$ (98.2 per cent), and 0.295 (1.8 per cent); $E/E^* = 1$: Emery gives two extrapolations to zero distance, as shown. The curves have been normalized to equal areas, by use of the lower extrapolation.

Figure 8, RaE , $E_0 = 1.17$, $E/E^* = 0.77$: The experimental data adjusted to give best apparent fit with the computed curve.

Figure 9, Na^{24} , $E_0 = 1.39$, $E/E^* = 1$: The smoothed data of Emery extend only to about 20 per cent of the maximum beta-particle range. Measurements were stopped at that point, due to the limitations on the size of the room, which gave an estimated 2 per cent scatter contribution from the walls. The fit is poor, but this is of doubtful significance, since the data are very limited, and are apparently about one-third extrapolated.

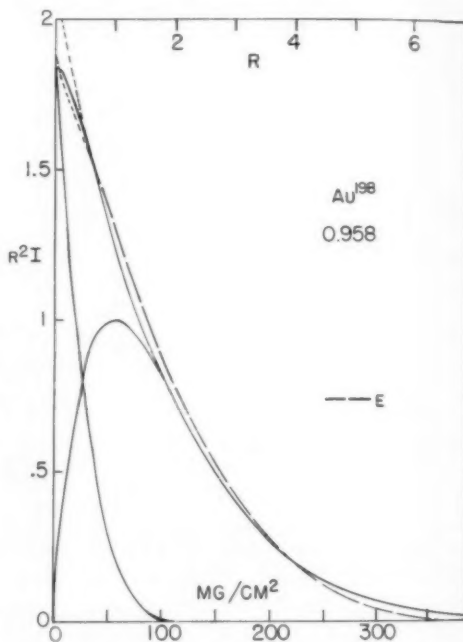


Fig. 7. Comparison of experimental data and computed distribution of energy for point source of beta particles in air, Au^{198} . See text.

Figure 10, Y^{91} , $E_0 = 1.56$, $E/E^* = 1.04$: The experimental data have been adjusted to give the best apparent fit with the computed curve.

Figure 11, P^{32} , $E_0 = 1.71$, $E/E^* = 1$: The data have been adjusted to give the best apparent fit with each other, and with the computed curve.

Figure 12, Sr^{90} , $E_0 = 0.536$, $E/E^* = 1.17$; and Y^{90} , $E_0 = 2.24$, $E/E^* = 1.02$: Experimental data adjusted to best apparent fit with computed curve.

Figure 13, K^{42} , $E_0 = 3.58$ (75 per cent), and 2.04 (25 per cent); $E/E^* = 1$ (probably, but not certainly): This is the most energetic of the beta-particle spectra on which any measurements have been made. Emery made measurements out to about 5 per cent of the maximum beta-particle range, as shown. K^{42} is a complex spectrum, with two components. The computed energy distribution for each component is shown, as well as the sum. These computed curves represent an un-

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warranted extrapolation from spectra of lower energy, and are presented to indicate that measurements on very high energy beta-particle spectra would be of great interest.

Figures 2 to 13 summarize in graphical form all of the data available at present on the point-source energy distribution in air. The representation of the data by the

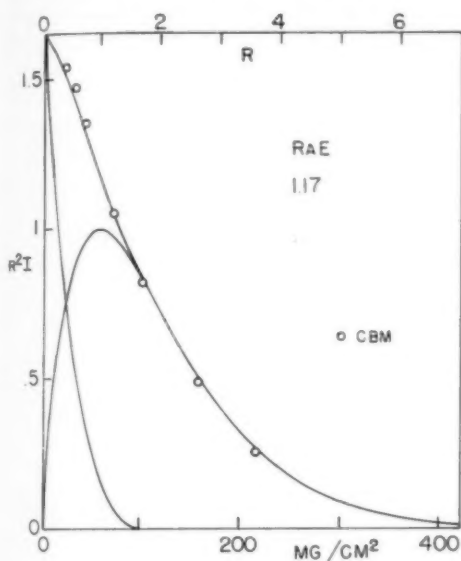


Fig. 8. Comparison of experimental data and computed distribution of energy for point source of beta particles in air, RaE. See text.

proposed function seems to be adequate for purposes of dosimetry. No claim is made that the functional representation is exact. On the contrary, it must be incorrect, at least near the end of the beta-particle range.

The measurements made on plane beta-particle sources in polystyrene can also be represented by Equation 2, but now the parameters μ and c have the values

$$\mu = \frac{18.2}{(E_0 - 0.036)^{1.57}} \left(2 - \frac{E}{E^*} \right) \quad (6)$$

$$c = 1 \quad (7)$$

When c has the value of unity, Equation 2 simplifies to the formula

$$r^2 I = k \left\{ [1 - re^{1-r}]_1 + [re^{1-r}]_2 \right\} \quad (8)$$

$$[]_1 \equiv 0, r \geq 1$$

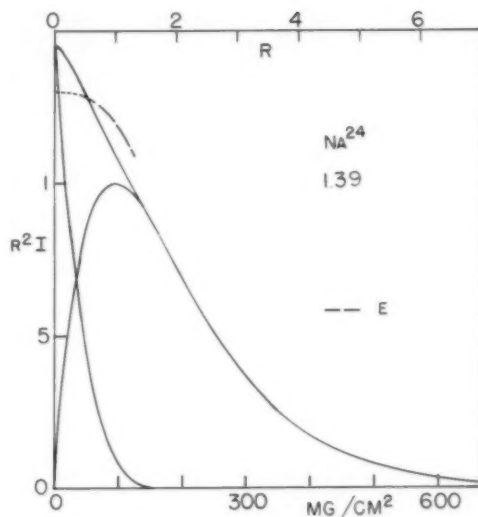


Fig. 9. Comparison of experimental data and computed distribution of energy for point source of beta particles in air, Na^{24} . See text.

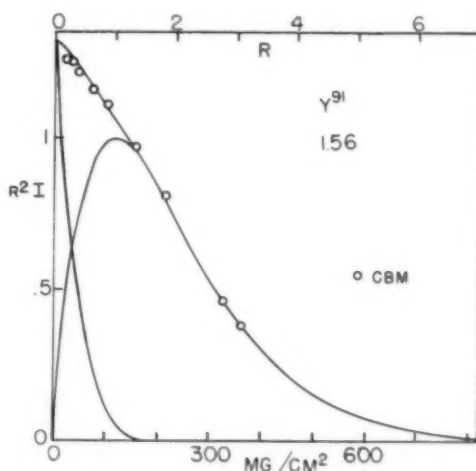


Fig. 10. Comparison of experimental data and computed distribution of energy for point source of beta particles in air, Y^{91} . See text.

It will be noted in this formula that for values of the dimensionless distance r less than unity, the two exponential terms cancel out, giving inverse square attenuation only, out to that distance. While Equation 6 applies only to polystyrene, Equations 7 and 8 have been found to apply to all the solids for which data are available

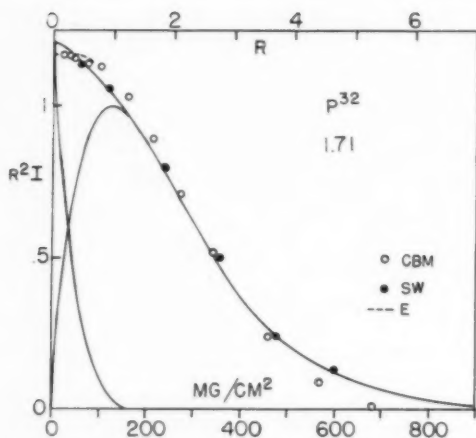


Fig. 11. Comparison of experimental data and computed distribution of energy for point source of beta particles in air, P^{32} . See text.

on measurements made under appropriate conditions (4, 6, 7, 9, 11). The data are not presented here, but it can be said that the fit of this plane-source data is even better than the fit of the point-source data. It should be noted, however, that the value of c is not too well determined, partly due to incomplete data, partly due to the insensitivity of the plane-source measurements to the value of c .

The value of μ given for polystyrene by Equation 6 has been well determined, from S^{35} to Rh^{106} . Moreover, it is to be stressed that the values of μ given for air by Equation 4 and for polystyrene by Equation 6 are in fact comparable, even though the former were made on a point source and the latter were made on plane sources. For the necessary and sufficient condition that a plane source show exponential absorption is that a point source be represented by the term in bracket sub 2 in Equation 2. The values of μ for polystyrene were taken from semi-log plots of absorption curves. The values of μ for air were taken from semi-log plots of the product xI , which evidently is exponential, for part of the beta-particle range, according to Equation 1.

In summary thus far, it appears that the proposed two-parameter function of Equations 1 and 2 represents reasonably well

the distribution of the energy from a point source of beta particles in an absorbing material of low atomic number. This has been established primarily by the very careful point-source measurements of Clark and his colleagues in Chicago, Emery in England, and Sommermeyer and Waechter

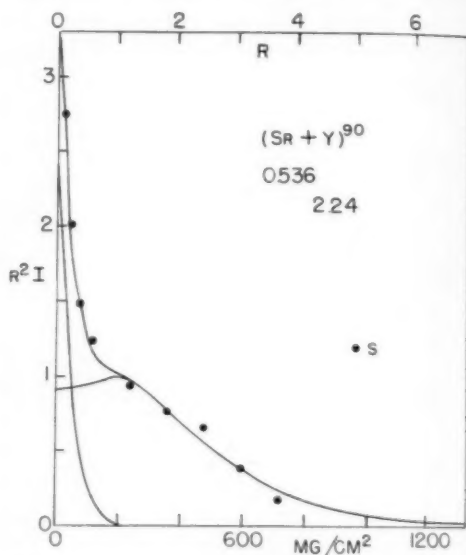


Fig. 12. Comparison of experimental data and computed distribution of energy for point source of beta particles in air, $(Sr + Y)^{90}$. See text.

in Germany. These groups appear to have handled this difficult experimental problem with great skill. The same function, though with different values of the parameters, represents available data in solids. What then are the best values of the parameters to use with the point-source function in tissue?

In an attempt to answer this question, the pertinent beta-particle absorption coefficients have been assembled in Figure 14. This includes all available absorption coefficients, measured with an ionization chamber under conditions of saturated scatter, for radionuclides for which measurements exist in air and one other absorbing material of low atomic number. The radionuclides are identified by the maximum beta particle energy, shown to the right of the polystyrene line. Sources for

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Examination of Figure 14 indicates that the absorption coefficient per electron is very nearly, though not quite, independent of the amount of hydrogen in a hydrogen-carbon-oxygen-nitrogen mixture. It would appear to be better to use the polystyrene values of the absorption coefficient, to get values for tissue, rather than start with the air values.

Based on these, and certain other considerations, it is suggested that the two-parameter function of Equations 1 and 2 is a satisfactory representation for purposes of dosimetry of the beta-particle point-source energy-distribution function in soft tissue, using the following values of the parameters:

$$\mu = \frac{18.6}{(E_0 - 0.036)^{1.37}} \left(2 - \frac{E}{E_0} \right) \quad \text{cm.}^2/\text{gm. of tissue} \quad (9)$$

$$c = \begin{cases} 2 & 0.17 < E_0 < 0.5 \text{ Mev} \\ 1.5 & 0.5 < E_0 < 1.5 \\ 1 & 1.5 < E_0 < 3 \end{cases} \quad (10)$$

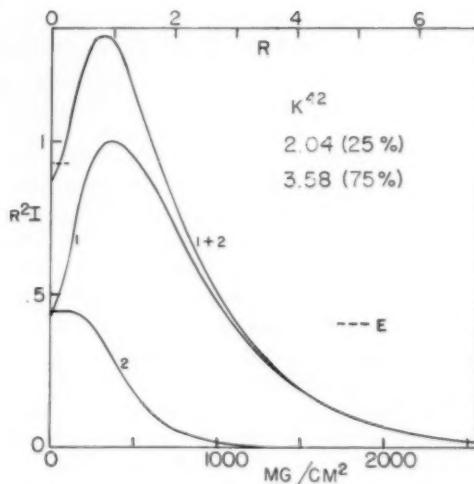


Fig. 13. Comparison of experimental data and computed distribution of energy for point source of beta particles in air, K^{42} . See text.

Thus, the shape of the function has been determined by the point-source measurements in air, the mass absorption coefficient μ has been taken from the polystyrene

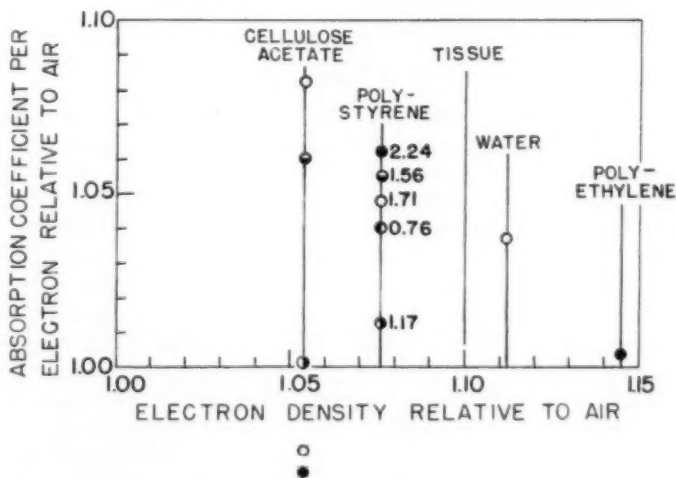


Fig. 14. Comparison of beta-particle absorption coefficients measured in different materials. The maximum beta-particle energy E_0 in Mev is indicated to the right of the point on the polystyrene line. Air values are from data cited in the text. The polystyrene measurements have been given by the author (6). The value for Y^{90} in polyethylene is by Jalbert (3). The value for P^{32} in water is by Sinclair and Blondal (9). The upper points for P^{32} and Y^{90} in cellulose acetate are from Raper, Zirkle, and Barnes (7). The lower points for P^{32} and Y^{90} in cellulose acetate are by Sommermeyer (11), and are so far out of line with the other data that they appear to be in error. The point for RaE just slightly above the axis of abscissae is from Kastner and Greenberg (4).

measurements corrected slightly for the electron density of tissue, and some rounded-off values of c have been specified, presumably accurate enough for purposes of dosimetry. These provisional values of μ and c will no doubt be superseded by future experimental and theoretical values.

Theoretical work on beta-particle energy distribution has been reported by Roesch (8), based on the age-diffusion theory of electron attenuation, and by Spencer (12), based on multiple scattering theory. Their results indicate good agreement with experiment, within certain limits. No doubt future investigations, guided by these new theories, will put this problem on a sound basis.

ACKNOWLEDGMENT: It is a pleasure to acknowledge the co-operation of Prof. Sommermeyer and Drs. Emery and Clark, who made their data available before publication.

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SUMARIO

La Dosimetría de los Focos Beta en el Tejido. La Función del Foco en Punto

De varios países han comunicado mediciones de la distribución de la ionización alrededor de un foco en punto de partículas beta en el aire. Preséntanse gráficas para demostrar que todas esas mediciones quedan bastante bien representadas con una sencilla función matemática con dos parámetros.

Puede usarse una representación seme-

jante para mediciones en focos planos en absorbentes sólidos. A base de una comparación de las mediciones al aire y en sólidos, se sugiere una representación provisoria para la función del foco en punto de partículas beta en tejido blando. Por ahora, esto servirá de base satisfactoria para la dosimetría de los focos de partículas beta distribuidos en los tejidos.

The Effect of Oxygen on the Radiosensitivity of Mammalian Cells¹

ALAN D. CONGER, Ph.D.

THE EFFECT OF oxygen concentration on the radiosensitivity of cells has been extensively investigated in bacteria, plants, and lower animals (1, 2). Nearly all the biological materials studied have shown that, as oxygen concentration is increased from anoxia to that of air, there is a sharp, approximately threefold, increase in radiosensitivity; but sensitivity is little enhanced, if at all, with higher concentrations.

This "oxygen effect" appeared, in theory, to offer some usefulness for radiotherapy. The rationale has been presented by L. H. Gray and his associates in the *British Journal of Radiology* (1). In brief, it is as follows: Tumors are generally more anoxic than the normal tissues around them. Thus a tumor, since it is anoxic, occupies a low position on the oxygen-radiosensitivity curve as compared with normal, well vascularized tissue, which stands high on the radiosensitivity curve and, most important, is close to the plateau of maximum sensitivity. It might be possible, therefore, to increase the tumor radiosensitivity relative to that of normal tissue, by subjecting the whole animal to increased oxygen tension.

On the basis of this possibility, it was important to establish that the radiosensitivity of mammalian cells was, in fact, affected qualitatively and quantitatively in the same way as the organisms previously investigated. The experimentally favorable material, Ehrlich mouse ascites tumor, was used to obtain data for mammalian cells. It grows rapidly as a free-cell suspension in the peritoneal cavity, is easily transferred, and gives 100 per cent takes. The strain used in one study was kindly furnished by Dr. George Klein (3).

Ascites fluid containing the rapidly

dividing tumor cells was withdrawn from animals inoculated six days previously, and was diluted with about one-fourth its volume of dextrose-saline plus heparin to prevent clotting. The fluid was equilibrated with atmospheres of various oxygen concentration by passing a jet of the gas, which stirred the fluid, over the surface for ten minutes before and during the *in vitro* irradiation. Since the tumor cells were freely suspended in the fluid, we can be quite certain that the cells themselves were in equilibrium with the gas. After irradiation, the fluid was re-inoculated into fresh mice, and then examined periodically in samples drawn by peritoneal puncture.

In the cytological experiments, which will be described first, small samples of the irradiated fluid were withdrawn at various intervals following inoculation. The cells were fixed and stained, and the proportion of dividing cells showing abnormal anaphase division, that is, cells in anaphase which had chromosomal bridges, chromosomal fragments, or both, was determined. The prediction would be made, on perfectly sound genetic grounds, that such abnormal anaphase divisions would produce inviable daughter cells. Figure 1 shows the result of an experiment. Each curve represents a single lot of fluid which was irradiated *in vitro* under the gas and with the dose shown, then re-inoculated into a single mouse, and sampled for eight days thereafter. The percentage of normal anaphases, *i.e.*, divisions which should produce viable daughter cells, is plotted as a function of time after irradiation and re-inoculation for the different doses in the three gases, nitrogen (anoxia), air (21 per cent oxygen), and pure oxygen. The

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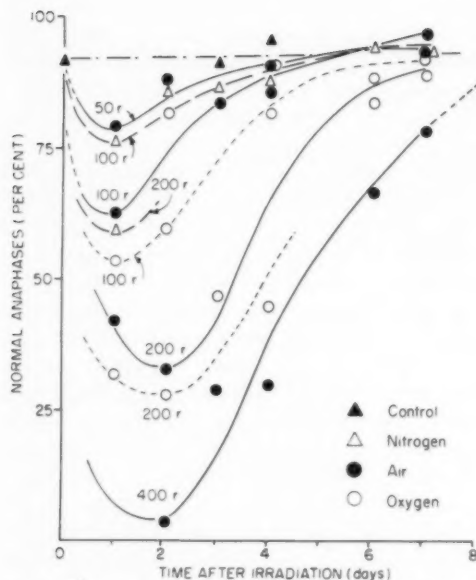


Fig. 1. Cytological abnormality of Ehrlich mouse ascites tumor growing *in vivo*, after x-irradiation *in vitro* in nitrogen, air, and oxygen. (Reproduced by permission of New York Academy of Science)

curves show that a minimum of normalcy is struck at about twenty-four hours after irradiation; thereafter the cell population becomes more and more normal with increasing time, *i.e.*, with succeeding divisions. This is to be expected, since we know that abnormal divisions produce inviable daughter cells, and hence do not contribute to the continuing population but gradually disappear. The cells have suffered genetic death. The non-damaged cells, on the other hand, continue to divide until they finally make up the entire population. It is also seen that with increasing dosage fewer cells are normal; and for the same dose, fewer are normal in oxygen than in air, and fewer in air than in nitrogen. For the present purpose, the most useful feature of these data is that they show that a minimum of normalcy is reached at about twenty-four to forty-eight hours after irradiation for all doses, as long as these are not so large that more than 80 to 90 per cent of the cells are affected. This deep minimum of normalcy at about twenty-four to forty-eight hours represents the

large bulk of the initial population which was in a resting stage when irradiated and is now dividing for the first time. If data are extracted from this first figure, taking the percentage of normal cells at the time of minimum normalcy as a function of dose in nitrogen, air, and oxygen, the next

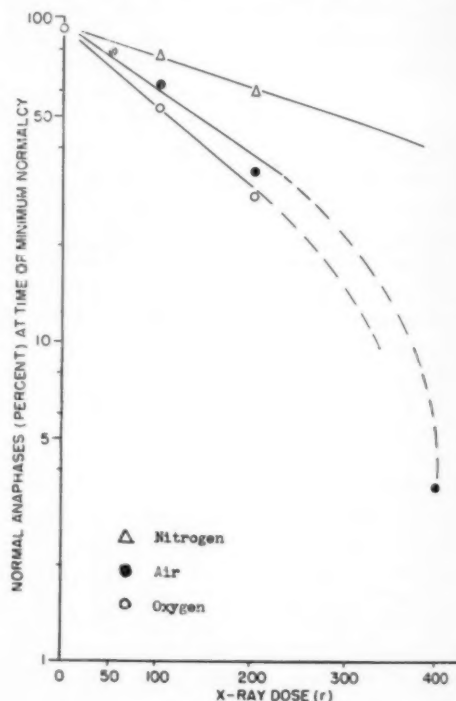


Fig. 2. Cytological abnormality, at time of minimum normalcy, as a function of *in vitro* x-ray dose in nitrogen, air, and oxygen. Extracted from Fig. 1.

graph (Fig. 2) is obtained. It can be seen that, so long as not too great a proportion of cells is affected, a simple logarithmic decrease with dose gives an adequate fit to the data. Actually, since the minima for the various doses are broad and overlap in time, it can be shown that a single observation at twenty-four hours is sufficient to define the relation of normalcy to dose. It is apparent from the figure that, for an equal dose of x-rays, the cells are much less affected in nitrogen than in air or oxygen. Comparing the slopes of the three dose curves, we find the radiosensitivity of the cells in nitrogen, air, and oxygen to

be in the order 1:3.7:4.7 for this particular experiment. The greatest increase in radiosensitivity is found between nitrogen (anoxia) and air (21 per cent oxygen), a factor of 3.7 times; but only a slight further increase in sensitivity, 1.3 times, is found from air to pure oxygen.

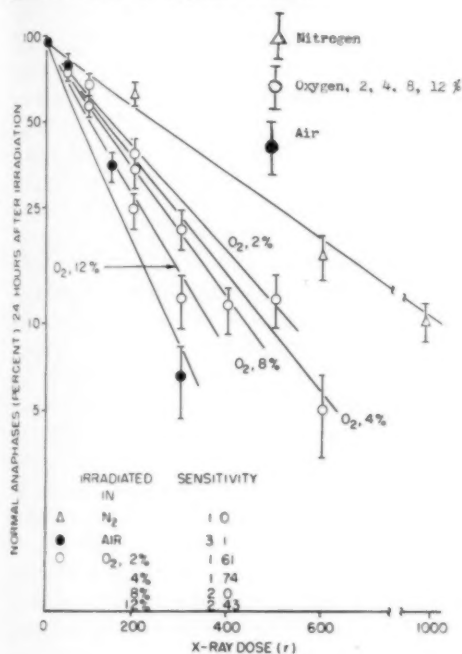


Fig. 3. Effect of oxygen concentration on radiosensitivity of ascites tumor cells. X-irradiated *in vitro*, examined twenty-four hours later (1).

A subsequent experiment was designed to show the effect of oxygen concentration on radiosensitivity in the region from zero oxygen to 21 per cent oxygen, where the greatest change in radiosensitivity had been found in the first experiment. The data are presented in Figure 3, showing, like Figure 2, a decrease in the proportion of normal divisions, at twenty-four hours, with increasing dose. For an equal dose of x-rays, the cells are progressively more affected as the oxygen concentration at the time of irradiation is increased. Comparing the slopes of the curves from irradiation in the different oxygen concentrations, we obtain the relative sensitivities shown at the foot of the graph; there is a fairly

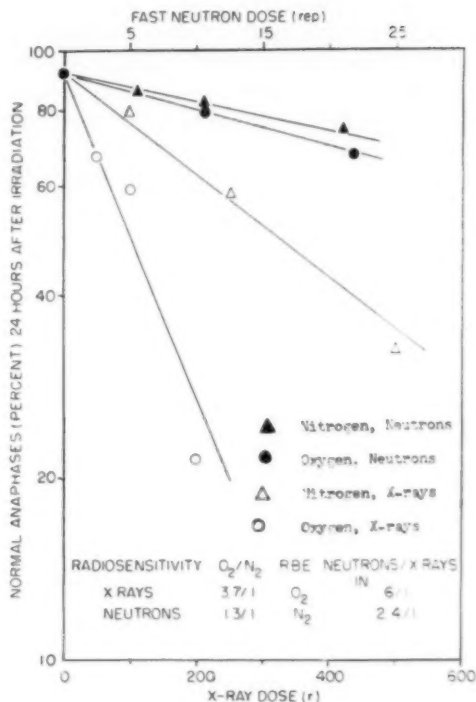


Fig. 4. Effect of oxygen concentration on radiosensitivity of ascites tumor cells irradiated *in vitro* with x-rays and with fast neutrons.

steep and approximately threefold increase in sensitivity in the range 0-21 per cent oxygen.

It had been demonstrated previously in other organisms that, while radiosensitivity is remarkably affected by oxygen when irradiation is performed with x-rays or gamma rays, oxygen is virtually without effect on sensitivity to densely ionizing particles such as fast neutrons or alpha rays. This is foreseeable on radiochemical grounds (4). It seemed worthwhile to confirm this feature of oxygen-radiosensitivity for mammalian cells also, which we did by irradiating the tumor *in vitro* under oxygen and nitrogen with x-rays and with fast neutrons. The lots of tumor were from a single pooled sample and all were irradiated at about the same time. These x-ray and neutron results are shown in Figure 4. The first fact to be noticed is that the cells are about 3.7 times as sensi-

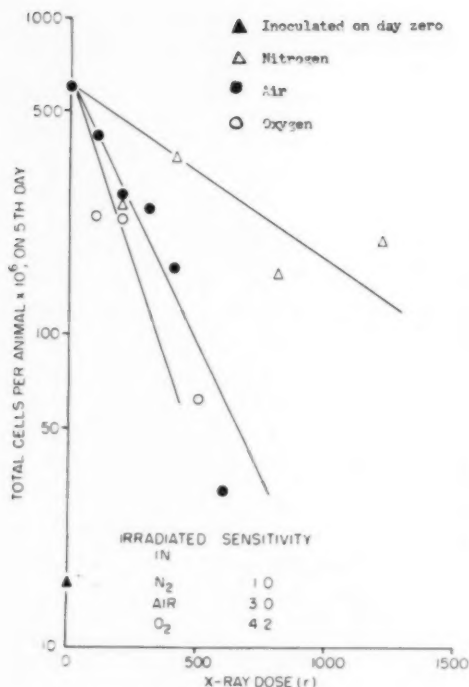


Fig. 5. Effect of oxygen concentration on five-day growth *in vivo* of ascites tumor cells. X-irradiated *in vitro*.

tive in oxygen as they are in nitrogen when irradiated with x-rays, but they are only 1.3 times as sensitive when irradiated with fast neutrons. We would expect that with even more densely ionizing radiation, such as alpha particles, there would be still less difference between oxygen and nitrogen.

One further and equally interesting fact is found in the data. If we compare the relative biological efficiency of neutrons to x-rays in causing this damage to ascites tumor cells, we find that in oxygen, neutrons are six times as damaging as x-rays, whereas in nitrogen the neutrons are only 2.4 times as effective. The relative biologic efficiency in oxygen is, therefore, 2.5 times as great as it is in nitrogen, for the same cells and effect. These results may have a particular relevance to some mammalian studies where a difference in relative biologic efficiency has been found for different tissues or different effects. On the basis of this experiment, one would predict that

poorly oxygenated or anoxic tissues would show a lower relative biologic efficiency than well oxygenated tissues in the same animal.

Another analysis of damage concerns the effect of oxygen on the growth and viability of x-rayed tumor cells (Fig. 5). The irradiation technic was the same as for the cytological experiments. Shortly after irradiation, a measured volume of fluid containing a known number of cells (about 15 million) was inoculated into recipient mice, all of which received the same number of cells. Four to 10 mice were inoculated from each irradiated lot. Five days later, *i.e.*, still during the period of exponential growth of the inoculum, the mice were sacrificed, the ascitic fluid volume was carefully measured, and cell counts were made. The total cell numbers per animal on the graph are averages. The points for these growth experiments show a greater scatter about the dose curve than did the cytological experiments, probably because of greater variation in size and age of the animals used and greater errors associated with the sampling technic.

For each curve there is, with increasing dose, a clear-cut reduction in the amount of cell growth that occurred in a five-day period after inoculation. The unirradiated samples had increased about fortyfold in cell number in this time, as can be seen by comparison with the number of cells inoculated on day zero. There was no statistical difference in the average total cell number on the fifth day for the unirradiated control samples treated with nitrogen, air, or oxygen, and they are grouped here. There is, however, a difference in depression in growth of the cells, depending upon the gas in which they were irradiated; this difference is approximately the same as was found on the basis of cytological damage, as described above. In this growth experiment, cells were found to be 3.0 and 4.2 times as sensitive in air and oxygen as they were in nitrogen. A repetition of the experiment, using about the same number of mice and comparable doses, gave substantially the same quanti-

tative results. We are inclined to believe that these growth results are, in fact, to be explained by the death of some of the irradiated cells, the proportion of cells killed increasing with dose and with oxygen tension, and not by a delay in division or a decreased division rate as a result of the ir-

radiation. Observation of the mitotic index at various times after irradiation showed that, within the dose range used here, the cells had recovered, approximately, their normal division rate in about twenty-four hours. Such delay as occurred could not account for the depression in growth.

The results from the cytological and growth experiments are in substantial agreement with each other and, as is shown in Figure 6, with the results obtained earlier with other organisms in which the oxygen effect had been extensively studied, such as the *Vicia* (5) or broad bean root and the flowering plant *Tradescantia* (6). Our data as represented here are derived from the cytological experiments already shown. Had we included the results from all the x-ray experiments discussed, they would have fallen on or close to the line drawn. When we consider the sensitivity of cells under anoxic conditions as unity, their sensitivity increases steeply, about threefold, in going to 21 per cent oxygen (air); any further increase in oxygen tension causes little increase in sensitivity. This final curve, therefore, represents the

overall elevation in oxygen tension of the whole organism, by breathing pure oxygen for example, would move both tissues over the curve, causing little increase in sensitivity of the normal tissue, but a considerable increase in tumor sensitivity. A differential effect is thereby achieved. The usefulness of this knowledge, of course, depends critically upon what positions the tissues actually occupy on this curve. Experiments utilizing this concept have produced encouraging results. Their discussion, however, is beyond the scope of this work, which was to furnish the experimental evidence that mammalian cells display the same oxygen effect as had been found in other organisms.

ACKNOWLEDGMENTS: This work was done while the author was a Fulbright Senior Research Scholar at Dr. L. H. Gray's laboratory in London, a unit of the Medical Research Council of England. Sincere appreciation is hereby expressed to the Fulbright Commission, Dr. Gray, and the Medical Research Council.

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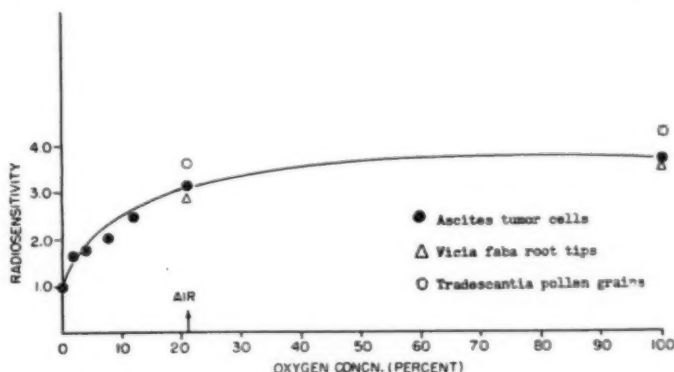


Fig. 6. Radiosensitivity of ascites tumor cells as a function of oxygen concentration. Derived from Figs. 2 and 3 (1).

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SUMARIO

El Efecto del Oxígeno sobre la Radiosensibilidad de las Células de Mamífero

Descríbense aquí experimentos encaminados a determinar el efecto del oxígeno sobre la radiosensibilidad de las células de mamífero. Estudios anteriores en bacterias, plantas y animales inferiores habían demostrado que, a medida que aumenta la concentración de oxígeno de anoxia a aire, obsérvase un aumento agudo de la radiosensibilidad.

Una suspensión de células libres del tumor ascítico de ratón de Ehrlich fué irradiada *in vitro* en atmósferas de diversas concentraciones de oxígeno. Utilizáronse dos pautas para apreciar el daño causado: (1) la intensidad del deterioro citológico medida en porcentaje de células que revelaban división anafásica anormal y (2) la proporción del deterioro experimentado en el crecimiento y la viabilidad celulares, medida en aumento del número de células en un período de cinco días de crecimiento

in vivo después de la irradiación. La primera es un efecto que puede predecirse, por razones genéticas, que ocasionará letalidad celular, en tanto que la segunda es una medición real del efecto sobre el crecimiento y la sobrevivencia de las células. Las dos pautas de deterioro convinieron cuantitativamente entre sí, y además con los datos obtenidos anteriormente en los animales inferiores. Se descubrió que triplicaba la sensibilidad de las células de mamífero a la irradiación roentgen, pero que el oxígeno no ejercía o apenas ejercía efecto cuando se exponían las células a una densa radiación yonizante (neutrones velozes).

Los experimentos sobre el crecimiento en que se inyectaron en ratones vivos, células irradiadas de acuerdo con las precisadas condiciones, mostraron resultados esencialmente semejantes.

DISCUSSION

Andrew H. Dowdy, M.D. (Los Angeles, Calif.): Dr. Conger's paper and related work in the basic fundamentals of radiation biology holds considerable interest to those of us concerned with the therapeutic applications of radiation. It has been common knowledge for years that the vascularity of the tumor bed is an important factor in the response to radiation of any given tumor. A squamous-cell cancer of the skin of the face, with a good blood supply and freely movable over the underlying structures, responds well. The converse holds for a similar type of cancer which has developed in an avascular fibrotic scar such as a keloid developing after

a severe burn. These and similar circumstances resulted in Bennett and Dowdy conducting a series of experiments in 1950 on the effect of anoxia on whole-body irradiation in rats. They found that when these animals were subjected to atmospheres of 5 per cent oxygen during the period of irradiation, their resistance to the radiation was approximately doubled (*Radiology* **55**: 879, 1950). Similar effects were obtained relative to the hematopoietic system. The work of L. H. Gray and associates demonstrated the enhancing effect of oxygen on tumor cells both *in vitro* and *in vivo*.

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found that x-irradiation *in vitro* of essential fatty acids or dilute aqueous suspensions of their methyl esters initiates a chain reaction resulting in the production of free radicals containing double-bond systems, and in the accumulation of organic peroxides. Of great interest is the fact that these *in vitro* reactions may persist up to one hour post-irradiation. A state of partial O_2 depletion results in a very great reduction in this chain reaction.

This brings us to a possible important practical application of this principle. Clinical radiation literature is replete with statements to the effect that

rather severe degrees of anemia do not constitute contraindications to radiation therapy. These statements in the main are probably true. Basic experiments, however, point to the fact that perhaps the sensitivity of many cancers to radiation might be greatly increased and, as Dr. Conger has pointed out, without increasing the sensitivity of the normal tissues, if we would use transfusion in anemic patients to the extent of bringing their hemoglobin to a normal level and keeping it there. Certainly this is a point worthy of consideration and one which requires further study.



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Absorption in Different Tissues of Cobalt 60 Gamma Radiation and Roentgen Rays with Half-Value Layers from 1 mm. Al to 5 mm. Cu¹

LILLIAN E. JACOBSON, M.A., F.A.C.R. (Assoc.), and ISABELLE KNAUER, M.A.

VARIOUS INVESTIGATORS have measured or calculated the absorption of x-rays and gamma rays in different kinds of tissue.

In 1921, Failla (1) published half-value layers and coefficients of absorption of radium gamma rays for absorbers of different fresh tissues. Although his method of measurement differs from ours, the values are in good agreement, as shown in Table I.

TABLE I: COMPARISON OF COEFFICIENT OF LINEAR ABSORPTION, μ , AND MASS ABSORPTION COEFFICIENT, μ/ρ , WITH THOSE OF FAILLA FOR A 5 X 5 CM. FIELD

Tissue	μ		μ/ρ	
	Ra (Failla)	Co60 (J & K)	Ra (Failla)	Co60 (J & K)
Muscle	0.069	0.061	0.067	0.061
Fat	0.065	0.055	0.069	0.062
Spongy bone	0.075	0.072	0.065	0.063
Lung	0.045	0.018	0.057	0.056

Quimby (2) measured the h.v.l. in air and at a depth of 10 cm. in tissue and in paraffin to determine the change in quality of the beam as it traversed material. With her associates (3), she measured also the depth doses in a cadaver for 200 kv, 700 kv, and gamma radiation and compared them with those obtained in a water phantom. It was found that the differences were not important except for the intraoral and thoracic regions, for which correction curves were given.

Weatherwax (4), in 1930, measured the transmission of roentgen rays from a 200-kv generator through an excised human lung which was connected to an air-pressure system and submerged in a water phantom of 20 cm. depth. The upper surface of the lung was 2 cm. from the surface of the water. Measurements were made directly under the lung when it was 3 cm. thick in the collapsed state, and when

inflated to a thickness of 6 cm., 9 cm., and 13 cm. The ratio of the measurement at a depth of 15 cm. between the lung in the collapsed state and the lung inflated to 9 cm. was 1:1.8. The dose at a depth of 15 cm. was thus increased by 80 per cent, when x-rays passed through the lung rather than through water.

Nahon (5, 6), using roentgen rays with a h.v.l. of 1.5 mm. Cu, found that the transmission through fresh calf's lung paralleled transmission through a plywood phantom with a density of 0.5 gm./c.c. At depths of 5, 10, and 15 cm. the dose was 25, 55, and 70 per cent higher, respectively, than the dose in a Presdwood phantom. Ordinary depth dose data, therefore, must be qualified before they can be used for dosage work on lung tumors.

Kornelsen (7) estimated the tumor dose in the chest from a measurement of the exit dose and found the result to be in satisfactory agreement with measurements in a phantom with "lung" material having a specific gravity of 0.46. He used radiation of 1.3 mm. Cu h.v.l.

Depth-dose and back-scatter measurements for soft roentgen rays were made in beef muscle by Trout and Gager (8).

The dose for roentgen radiation of different wave lengths at an interface between bone and soft tissue and in tissue-filled cavities in the haversian canals of bone was calculated by Spiers (9-11), Wilson (13), and Meredith (14). Spiers (12) made absorption measurements on freshly excised human bones, using a wave-length region between 0.42 Å and 0.48 Å. Uniform layers of bone powder in Perspex cells and flat sections of bone were measured. The calculations indicate that the tolerance dose

¹ From the Radiotherapy Department, Montefiore Hospital, New York, N. Y. Presented at the Fortieth Annual Meeting of the Radiological Society of North America, Los Angeles, Calif., Dec. 5-10, 1954.

of soft-tissue elements in the bone is about one-third that of soft-tissue elements outside the bone with medium voltage, and one-half with 200 to 250 kv, while for short wave lengths of about 1 Mev the soft-tissue tolerance within the bone and outside is almost the same. This does not mean that bone tumors are best treated by the lower voltages, since the spatial distribution of the tumor is much too great for the short-range additional ionization from the heavy bone elements to increase the tumor dose except for such cells as happen to be immediately adjacent to the bone itself. The limit of dose to the bone is imposed by the soft tissues enclosed in the haversian system and not by the soft tissue in the field of the tumor.

EXPERIMENTAL WORK

The range of energy from 100-kv unfiltered roentgen rays to gamma rays of cobalt was investigated. The absorption was measured in muscle, lung, fat, compact bone, and spongy bone for 100 kv, h.v.l. 1.0 mm. Al; 140 kv, h.v.l. 0.41 mm. Cu; 200 kv, h.v.l. 0.9 mm. Cu; 400 kv, h.v.l. 4.9 mm. Cu; cobalt gamma radiation with an average energy of 1.25 Mev. Three different field sizes were used: 7×7 cm., 5×5 cm., and 2 cm. diameter.

Ionization measurements were made with a Victoreen 250-r chamber with an air volume of approximately 0.2 c.c. and a condenser dosimeter. The chamber was maintained at a fixed distance from the target or source. For measurements of cobalt gamma radiation, a 4-mm. Lucite cap was used on the chamber to obtain equilibrium conditions.

The absorbing material was placed on a holder of thin aluminum foil reinforced at the edges by cardboard. The aluminum was marked by two lines perpendicular to each other at the center. This holder was placed on a movable ratchet so positioned that the uppermost part of the absorbing material was always at the same fixed distance from the target or source. Figure 1 shows the set-up on the cobalt 60 beam therapy machine. On this machine the

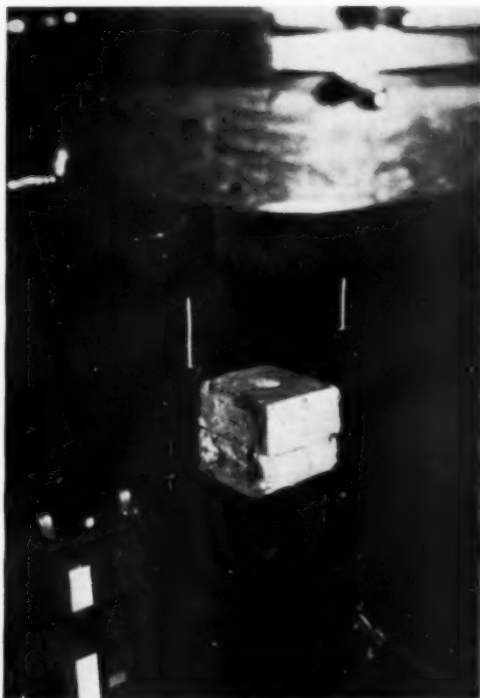


Fig. 1. Set-up for absorption measurements on Co^{60} beam therapy machine.

fields, of the dimensions given above, were obtained by a diaphragm system, with a special lead slug for the field of 2 cm. diameter. On the 100-kv, 140-kv, and 200-kv machines the fields were obtained by lead rubber cut-outs placed directly on the absorbers. The perpendicular markings on the lead rubber cut-outs were matched to the perpendicular marks on the aluminum holder, so that the center of the opening was over the chamber. On the 400-kv machine the 7×7 -cm. and 5×5 -cm. fields were obtained by a diaphragm system. The 2 cm. diameter field was obtained by placing a lead cut-out, 5 mm. thick, directly on the absorbers. On the cobalt and 400-kv machines light devices and cross hairs outlined the field and the center. A special needle plumb line was used to check the center throughout a run.

Beef muscle and fat were cut into the required cross sections, surrounded by four boards like those from a long cheese box,

and tied with string. The whole rectangular piece was put into a deep freezer and frozen solid, after which it was cut into slabs of the desired thickness on a meat-slicing machine. These slabs were kept on dry ice throughout the experiment except when used for the absorption measurement. The thickness of each piece was measured by calipers and recorded. The thickness was uniform throughout. The material did not melt during an absorption "run." Even ice treated in the same way remained dry during measurements.

A beef lung obtained from a freshly killed animal was inflated to what appeared "life" size, tied to keep the air from escaping (not an easy feat), and frozen hard. This was then sliced into the required thicknesses. These pieces remained frozen hard and dry throughout the absorption runs, being kept on dry ice in the intervals. The density of the pulmonary tissue varied according to the amount of air pumped into the lung. The density of one lung was 0.32 gm./c.c., of another 0.45 gm./c.c., and of frozen collapsed lung 0.87 gm./c.c. The thickness of each slab was uniform, but the density varied within a slab because of the air spaces of the bronchial tubes. Slabs in which there were visible differences were not used.

The bone was sliced into the specified thicknesses. The heads of the femur and the tibia were used to give a fairly uniform cross section of spongy bone. The density of this bone was 1.15 gm./c.c. The volume was found both by measuring length, width, and thickness on a squared-off piece, and by displacement of water for irregular pieces. The densities were in good agreement. The figure is quite different from that for compact bone, which was 1.85 gm./c.c. To obtain a single piece of compact bone large enough for a slab was something of a problem. For our measurements, several pieces were put together to form each slab.

For the ice slabs, water was put into a plastic container, frozen, and then sliced. Water and rice were each measured inside of a plastic freezer container.

Some of the early experiments were made with the bottom slab of the absorber at a fixed distance from the source and the slabs piled one on top of the other. The size of the exit field then remained the same, but the size of the entering field was different with each additional slab. The difference between the two methods for bone and muscle is of the order of 10 per cent.

The various tissues were kept frozen on dry ice and measured the following day to see whether there was any change in the absorption. None was found.

Absorption measurements were made within a two-day period on all the machines for the same group of slabs. At least two different sets of each absorbing material were measured. With the exception of lung, where the density varied from time to time, and an occasional reading for other tissues, the deviation of a transmission value from the average was less than 10 per cent.

RESULTS

The per cent transmission *versus* thickness of muscle was plotted on semilog graph paper. Curves are shown in Figure 2 for the three fields used: 7×7 cm., 5×5 cm., and 2 cm. diameter, for 100-kv, 200-kv, and 400-kv generators, with h.v.l.'s of 1.0 mm. Al, 0.9 mm. Cu, 4.9 mm. Cu, respectively, and for cobalt 60 gamma radiation.

The measurements for 140 kv and 0.41 mm. Cu h.v.l. were not plotted on any of the graphs since the curves through them were so close to the curves for 200 kv that reading them was difficult. All the results, including values for 140 kv, are given in Table II. In a similar fashion the data for fat, spongy bone, compact bone, and lung were plotted and are shown in Figures 3, 4, 5, and 6, respectively.

To compare the absorption in the different kinds of tissue for a given quality of radiation, the per cent transmission is plotted *versus* thickness of tissue in Figure 7 for 200-kv roentgen rays and in Figure 8 for cobalt 60 gamma radiation, for a field

TABLE II: HALF-VALUE LAYER, COEFFICIENT OF LINEAR ABSORPTION (μ), AND MASS ABSORPTION COEFFICIENT (μ/ρ), FOR DIFFERENT TISSUES, KILOVOLTAGES, AND FIELD SIZES

Tissue and Radiation	Density, gm./c.c.	h.v.l. In centimeters for Field Size			In cm. ⁻¹ for Field Size			In sq. cm./gm. for Field Size		
		7 × 7 cm.	5 × 5 cm.	2 cm. Diam.	7 × 7 cm.	5 × 5 cm.	2 cm. Diam.	7 × 7 cm.	5 × 5 cm.	2 cm. Diam.
Muscle										
Co 60	1.0	12.1	11.3	10.8	0.057	0.061	0.064	0.057	0.061	0.064
400 kv	1.0	6.0	5.4	4.9	0.115	0.128	0.141	0.115	0.128	0.141
200 kv	1.0	4.4	4.1	3.7	0.157	0.169	0.187	0.157	0.169	0.187
140 kv	1.0	3.9	3.6	3.4	0.177	0.192	0.204	0.177	0.192	0.204
100 kv	1.0	1.4	1.3	1.2	0.50	0.53	0.58	0.50	0.53	0.58
Lung										
Co 60	0.32	40.5	39.0	34.5	0.017	0.018	0.020	0.054	0.056	0.063
400 kv	...	20.2	18.0	16.3	0.034	0.038	0.043	0.107	0.120	0.133
200 kv	...	15.5	14.7	14.2	0.045	0.047	0.049	0.140	0.147	0.152
100 kv	...	3.0	2.7	2.5	0.23	0.26	0.28	0.72	0.80	0.86
Fat										
Co 60	0.89	13.4	12.6	11.7	0.052	0.055	0.059	0.058	0.062	0.067
400 kv	...	7.6	6.6	4.9	0.091	0.105	0.141	0.102	0.118	0.158
200 kv	...	6.0	5.5	4.5	0.115	0.126	0.154	0.129	0.141	0.173
140 kv	...	5.0	4.5	4.0	0.138	0.154	0.173	0.155	0.173	0.194
100 kv	...	2.2	2.1	1.9	0.32	0.33	0.37	0.35	0.37	0.41
Spongy bone										
Co 60	1.15	10.2	9.6	8.9	0.068	0.072	0.078	0.059	0.063	0.068
400 kv	...	5.2	4.7	4.3	0.133	0.147	0.161	0.116	0.128	0.140
200 kv	...	3.7	3.4	3.2	0.187	0.204	0.216	0.163	0.177	0.188
140 kv	...	3.0	2.7	2.6	0.231	0.257	0.266	0.201	0.223	0.231
100 kv	...	1.0	0.7	0.6	0.69	0.99	1.15	0.60	0.86	1.00
Compact bone										
Co 60	1.85	...	...	6.7	...	...	0.103	...	...	0.055
400 kv	...	...	...	3.2	...	...	0.216	...	...	0.116
200 kv	...	...	...	1.3	...	...	0.53	...	...	0.29

of 2 cm. diameter. Measurements on tissue substitutes of ice and Presdwood of unit density are plotted in Figure 7, and for water, ice, Presdwood, rice, and cork of a density of 0.27 gm./c.c. in Figure 8.

The h.v.l. or 50 per cent transmission value is, as one would expect, smallest for compact bone and greatest for lung, with spongy bone, muscle, and fat in between. For both 200-kv and cobalt gamma radiation the absorption in ice approximates that in fat. Presdwood corresponds to frozen muscle. For cobalt gamma radiation, as seen in Figure 8, absorption in water is about the same as in frozen muscle. The absorption in rice is slightly less. It can be used, however, as a fair tissue substitute.

DISCUSSION

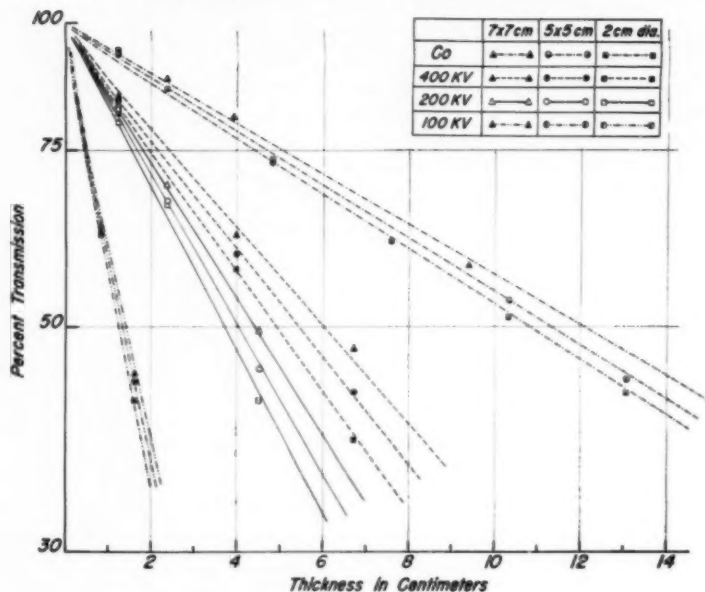
Factors Affecting Absorption: The linear coefficient of absorption changes with the

TABLE III: RELATIONSHIP BETWEEN KILOVOLTAGE, HALF-VALUE LAYER, EQUIVALENT WAVE LENGTH (λ_e), AND EQUIVALENT KILOVOLTAGE (kv_e)

kv	Filter (mm.)	h.v.l. (mm.)	λ_e in Å.	kv_e
100	None	1.0 Al	0.55	23
140	0.25 Cu, 1.0 Al	0.41 Cu	0.22	57
200	0.50 Cu, 1.0 Al	0.9 Cu	0.16	78
400	4.0 Cu, 1.0 Al	4.9 Cu	0.05	248
Co (gamma)			0.01	1250

different qualities of radiation from the low-voltage to the high-voltage. Corresponding to each kilovoltage and filter there is an equivalent or effective wave length, which is defined as the wave length of a homogeneous beam whose linear coefficient of absorption is the same as that of the given heterogeneous beam. The kilovoltage corresponding to this wave length is called the equivalent kilovoltage, kv_e . If λ_e is known, kv_e can be found by the well known equation, $kv_e = 12.4/\lambda_e$.

PERCENT TRANSMISSION OF Co^{60} GAMMA RAYS AND
ROENTGEN RAYS THROUGH BEEF MUSCLE



PERCENT TRANSMISSION OF Co^{60} GAMMA RAYS AND
ROENTGEN RAYS THROUGH BEEF FAT

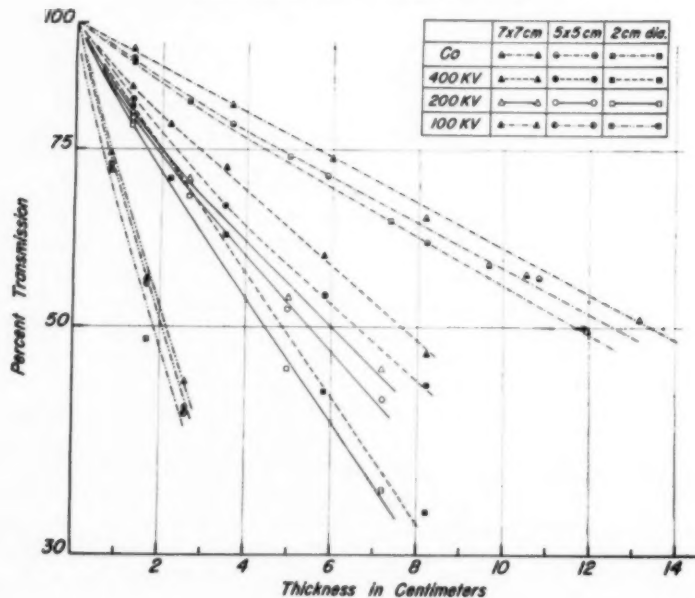


Fig. 2. Per cent transmission through varying thicknesses of beef muscle of cobalt 60 gamma radiation and roentgen rays from 100-kv, 200-kv, and 400-kv generators with h.v.l.'s of 1.0 mm. Al, 0.9 mm. Cu, and 4.9 mm. Cu, respectively, for fields of 7×7 cm., 5×5 cm., and 2 cm. diameter. Density of beef 1.0 gm./c.c.

Fig. 3. Per cent transmission through varying thicknesses of beef fat for cobalt 60 gamma radiation and roentgen rays from 100-kv, 200-kv, and 400-kv generators with h.v.l.'s of 1.0 mm. Al, 0.9 mm. Cu, and 4.9 mm. Cu, respectively, for fields of 7×7 cm., 5×5 cm., and 2 cm. diameter. Density of fat 0.89 gm./c.c.

The relationship between kilovoltage, filter, half-value layer, and the corresponding equivalent wave length and kilovoltage is shown in Table III. Roentgen rays produced by 200 kv, with an h.v.l. of 0.9 mm. Cu, have an equivalent wave length of 0.16 Å. and an equivalent voltage of 78 kv.

The linear coefficient of absorption, μ , is plotted versus kV_e in Figure 9, on a semi-logarithmic graph for different tissues,

TABLE IV: VARIATION OF COEFFICIENT OF LINEAR ABSORPTION (μ) WITH EQUIVALENT KILOVOLTS (kV_e) FOR A 2-CM. DIAMETER FIELD FOR DIFFERENT TISSUES

Tissue	23 kv. (100 kv)	57 kv. (140 kv)	78 kv. (200 kv)	248 kv. (400 kv)	1,250 kv. (Co 60)
Compact bone	...	...	0.532	0.216	0.103
Spongy bone	1.15	0.266	0.216	0.161	0.078
Muscle	0.58	0.204	0.187	0.141	0.064
Fat	0.36	0.173	0.154	0.141	0.059
Lung	0.28	...	0.049	0.043	0.020

PERCENT TRANSMISSION OF Co^{60} GAMMA RAYS AND ROENTGEN RAYS THROUGH BEEF SPONGY BONE

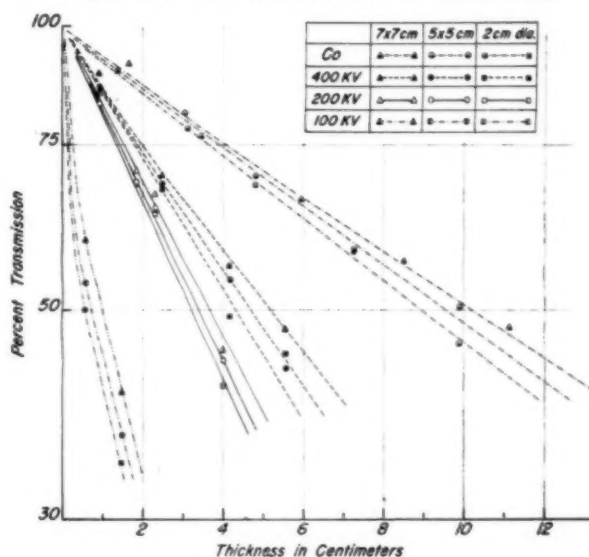


Fig. 4. Per cent transmission through varying thicknesses of spongy bone of cobalt 60 gamma radiation and roentgen rays from 100-kv, 200-kv, and 400-kv generators with h.v.l.'s of 1.0 mm. Al, 0.9 mm. Cu, and 4.9 mm. Cu, respectively, for fields of 7 × 7 cm., 5 × 5 cm., and 2 cm. diameter. Density of spongy bone 1.15 gm./c.c.

when a 2 cm. diameter field is used. The linear coefficient of absorption increases with the density of the tissue for a given kilovoltage and decreases as the voltage increases for the voltage range investigated. Table IV gives the data for this graph. Spiers (12) calculated the linear absorption coefficient after finding the effective atomic number, \bar{Z} , for compact bone, muscle, and fat for different wave lengths. In Table V our values are compared with his. The agreement is good except for a wave length

of 0.55 Å. or the 100-kv region, where our experimental values are considerably less than those of Spiers.

The mass absorption coefficient, μ/ρ , i.e., the diminution per gram per unit area of tissue is approximately the same at any given kilovoltage from 140 kv to cobalt gamma radiation for all tissues measured except compact bone (Table VI). For 100 kv, h.v.l. 1 mm. Al, λ_e 0.55 Å., there is a distinct difference in μ/ρ . It is lowest for fat and highest for spongy bone. (It was

TABLE V: COMPARISON OF COEFFICIENT OF LINEAR ABSORPTION (μ) FOR A 2-CM. DIAMETER FIELD WITH VALUES FOUND BY SPIERS FOR DIFFERENT EQUIVALENT WAVE LENGTHS (λ_e)

Tissue	λ_e 0.01 Å. (Co 60)		λ_e 0.05 Å. (400 kv)		λ_e 0.16 Å. (200 kv)		λ_e 0.22 Å. (140 kv)		λ_e 0.55 Å. (100 kv)	
	J & K	S	J & K	S	J & K	S	J & K	S	J & K	S
Compact bone	0.103	0.114	0.216	0.212	0.532	0.397	...	...	...	...
Muscle	0.064	0.069	0.141	0.126	0.187	0.189	0.204	0.222	0.577	0.754
Fat	0.059	0.066	0.141	0.118	0.154	0.171	0.173	0.192	0.365	0.459

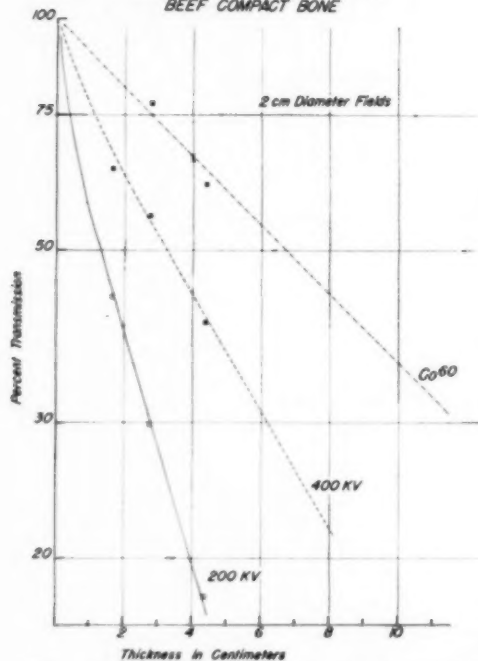
PERCENT TRANSMISSION OF Co⁶⁰ GAMMA RAYS AND ROENTGEN RAYS THROUGH BEEF COMPACT BONE

Fig. 5. Per cent transmission through varying thicknesses of compact bone of cobalt 60 gamma radiation and roentgen rays from 200-kv and 400-kv generators with h.v.l.'s of 0.9 mm. Cu and 4.9 mm. Cu, respectively, for a 2-cm. diameter field. Density of compact bone 1.85 gm./c.c.

not measured for compact bone at this voltage.) As calculated for lung tissue of different densities, 0.32 gm./c.c., and 0.87 gm./c.c., μ/ρ was found to be the same for a given kilovoltage regardless of density.

Energy is absorbed in tissue by three processes, (a) the production of photoelectrons, in which nearly all the energy of the incoming photon is transferred to the ejected electron, (b) the production of Compton or recoil electrons, where part of the energy of the photon is transferred

TABLE VI: VARIATION OF MASS ABSORPTION COEFFICIENT (μ/ρ) WITH kV_e FOR A 2-CM. DIAMETER FIELD FOR DIFFERENT TISSUES

Tissue	23 kv _e (100 kv)	57 kv _e (140 kv)	78 kv _e (200 kv)	248 kv _e (400 kv)	1,250 kv _e (Cobalt 60)
Compact bone	...	...	0.288	0.116	0.055
Spongy bone	1.0	0.231	0.188	0.140	0.068
Muscle	0.577	0.204	0.187	0.141	0.064
Fat	0.410	0.194	0.173	0.158	0.066
Lung	0.32	...	0.152	0.133	0.063

to loosely bound electrons, and (c) the process of pair production, where the energy of the incident photon, when greater than 1.02 Mev, is absorbed in the creation of a positive and negative electron and in giving them energy of motion.

The photoelectric absorption, T , is approximately proportional to $\lambda^3 Z^4$. At 100 kv both the photoelectric absorption and Compton absorption in water must be considered. From 200 kv up to 2 Mv, the absorption in water is mostly Compton absorption, σ . Absorption by pair production, π , begins to be important after 2 Mv, and therefore does not enter into any of our absorption measurements.

The coefficient of Compton absorption, σ , may be calculated by the Klein-Nishina formula (17):

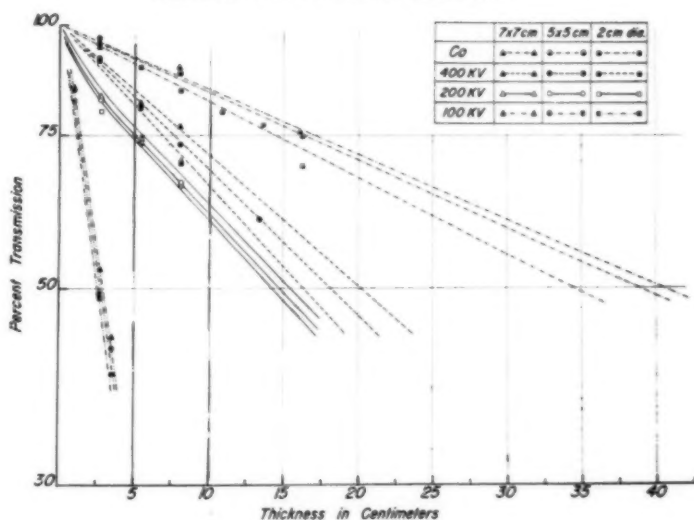
$$\sigma = \frac{2\pi n e^4}{m^2 c^4} \left\{ \frac{1 + \zeta}{\zeta^2} \left[\frac{2(1 + \zeta)}{1 + 2\zeta} - \frac{1}{\zeta} \ln(1 + 2\zeta) \right] + \frac{1}{2\zeta} \ln(1 + 2\zeta) - \frac{1 + 3\zeta}{(1 + 2\zeta)^2} \right\}$$

where n is the number of electrons per unit volume (18) and $\zeta = \frac{h\nu}{mc^2}$.

A comparison is made in Table VII of σ as calculated by this formula with the measured values of the linear coefficient of absorption, μ , for different kilovoltages.

TABLE VII: COMPARISON OF THE MEASURED LINEAR COEFFICIENT OF ABSORPTION (μ) WITH THE COEFFICIENT OF COMPTON ABSORPTION (σ) AS CALCULATED BY THE KLEIN-NISHINA FORMULA

Tissue	n	78 kv _e (200 kv)		248 kv _e (400 kv)		1,250 kv _e (Cobalt 60)	
		σ	μ	σ	μ	σ	μ
Compact bone	5.55×10^{23}	0.289	0.532	0.205	0.216	0.104	0.103
Spongy bone	3.80×10^{23}	0.198	0.216	0.141	0.161	0.072	0.078
Muscle	3.36×10^{23}	0.175	0.187	0.124	0.141	0.063	0.064
Fat	3.10×10^{23}	0.162	0.154	0.115	0.141	0.058	0.059
Lung	1.02×10^{23}	0.053	0.049	0.038	0.043	0.019	0.020

PERCENT TRANSMISSION OF Co⁶⁰ GAMMA RAYS AND ROENTGEN RAYS THROUGH BEEF LUNGFig. 6. Per cent transmission through varying thicknesses of lung tissue of cobalt 60 gamma radiation and roentgen rays from 100-kv, 200-kv, and 400-kv generators with h.v.l.'s of 1.0 mm. Al, 0.9 mm. Cu, and 4.9 mm. Cu, respectively, for fields of 7×7 cm., 5×5 cm., and 2 cm. diameter. Density of lung tissue 0.32 gm./c.c.

The agreement is good for cobalt, and fairly good for 400- and 200-kv radiation, with the exception of compact bone at 200 kv. Compact bone has an effective atomic number, Z , about twice that of muscle, and the photoelectric effect therefore becomes significant at 200 kv, accounting for most of the difference between the total absorption coefficient as measured and the Compton absorption coefficient as calculated by the Klein-Nishina formula.

A calculation was made to determine the effective kilovoltage, kv_e, at which the photoelectric absorption, T , in compact bone, was 10 per cent of the total absorp-

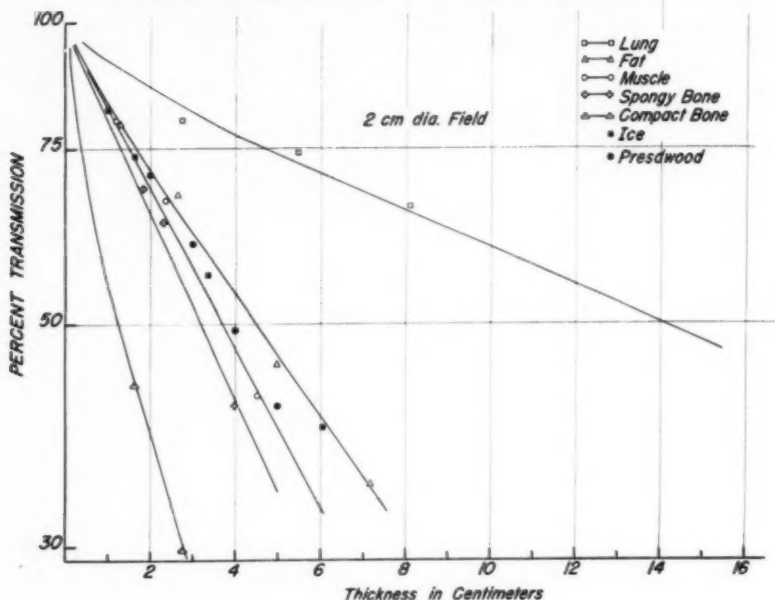
tion, μ . T was calculated from the following formula

$$\frac{T}{\rho} = 0.0089 \left(\frac{Z^{4.1}}{A} \right) \lambda^k$$

where $k = 2.85$, $\rho = 1.85$ gm./c.c., $Z = 13.8$, and $A = 2Z$. It was found that at 120 kv_e, the photoelectric absorption is 10 per cent of the total absorption. This corresponds to an h.v.l. of 2.35 mm. Cu, which would be approximately the quality of the radiation emitted by an x-ray tube with a 2-mm. Cu filter operated on a 250-kv generator.

Significance for Radiation Therapy: In

PERCENT TRANSMISSION OF 200 KV ROENTGEN RAYS
THROUGH VARIOUS TISSUES, ICE AND PRESWOOD



PERCENT TRANSMISSION OF Co⁶⁰ GAMMA RAYS THROUGH
VARIOUS TISSUES AND MATERIALS

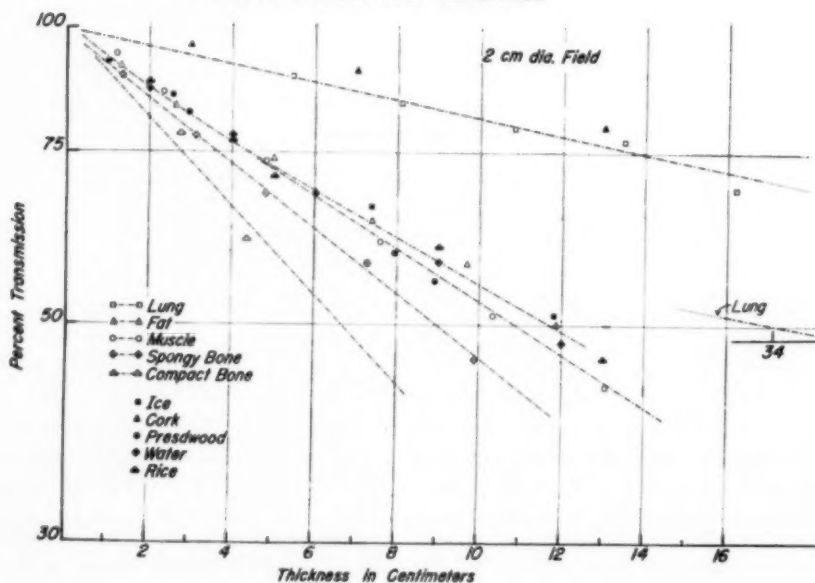


Fig. 7. Per cent transmission through varying thicknesses of muscle, fat, spongy bone, compact bone, lung, ice, and Preswood, of 200-kv roentgen rays, h.v.l. 0.9 mm. Cu, for a 2-cm. diameter field.

Fig. 8. Per cent transmission through varying thicknesses of muscle, fat, spongy bone, compact bone, lung, ice, cork, Preswood, water, and rice, of cobalt 60 gamma radiation for a 2-cm. diameter field.

therapy the ratio of the absorption in a given tissue to that in muscle is useful. In Figure 10 are plotted the ratios of μ/μ_{muscle} for lung, fat, spongy bone, and compact bone *versus* equivalent kilovolts. The corresponding kilovolts are indicated on the graph. The ratio changes very little

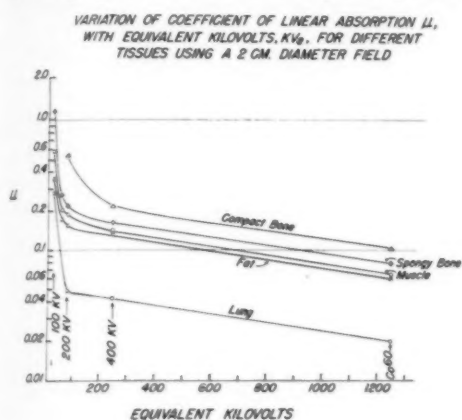


Fig. 9. Variation in the linear absorption coefficient (μ) with equivalent kilovolts (kv_e) for different tissues, using a 2-cm. diameter field.

from 400 kv (250 kv_e) to cobalt gamma radiation or 1,250 kv_e for any of the tissues measured. This means that the absorption differential between the given tissue and muscle is almost the same throughout this region. In fat the absorption is slightly less than in muscle; in spongy bone it is approximately 15 per cent higher than in muscle, and in compact bone 50 per cent higher. For lung of a density of 0.32 gm./c.c. the absorption is about one-third of that in muscle. This difference in absorption should be considered in calculating dosage in the treatment of lung neoplasms.

At 200 kv there is a greater difference between compact and spongy bone than at 400 kv. At the lower voltage, compact bone absorbs 2.9 times as much as muscle, and spongy bone only 1.15 times as much. At 400 kv, compact bone absorbs 1.5 times as much as muscle and spongy bone 1.14 times as much. When treatments are given through the bony structure, the radiation generally traverses both spongy

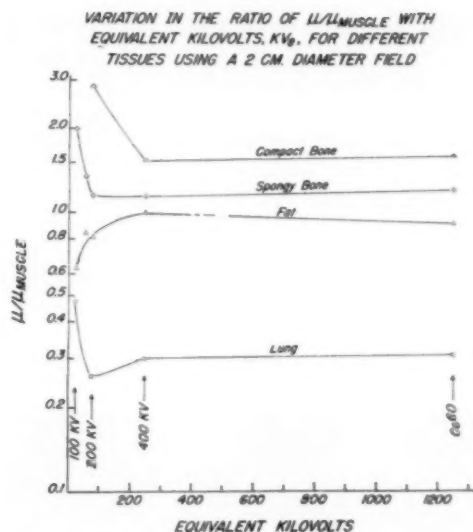


Fig. 10. Variation in the ratio of the linear absorption coefficient of the given tissue to that of muscle (μ/μ_{muscle}) with equivalent kilovolts (kv_e) for different tissues, using a 2-cm. diameter field.

TABLE VIII: VARIATION OF μ/μ_{muscle} WITH kv_e FOR A 2-CM. DIAMETER FIELD FOR DIFFERENT TISSUES

Tissue	23 kv_e (100 kv)	57 kv_e (140 kv)	78 kv_e (200 kv)	240 kv_e (400 kv)	1,250 kv_e (Co 60)
Compact bone	...	...	2.85	1.53	1.61
Spongy bone	1.98	1.33	1.15	1.14	1.21
Fat	0.63	0.85	0.82	1.00	0.92
Lung (0.32 gm./c.c.)	0.48	...	0.26	0.30	0.31

and compact bone. To get the least effect on the bone, voltages of 400 kv and higher may be advisable. The values μ/μ_{muscle} for the different tissues and kv_e are found in Table VIII.

That the ratio μ/μ_{muscle} remains approximately the same does not imply that the absorption is the same at 400 kv as for cobalt. The absorption in the tissue and in muscle decreases at the same rate, thus leaving the ratio of the absorption in tissue to muscle approximately the same. Below 400 kv the absorption in compact bone compared to that in muscle increases rapidly, while the absorption in fat compared to that in muscle decreases. The

TABLE IX: COMPARISON OF DEPTH DOSES MEASURED BY JOHNS WITH DEPTH DOSES FOR MUSCLE CALCULATED BY USING A 2-CM. DIAMETER FIELD AND CORRECTING FOR THE INVERSE SQUARE AND SCATTER EFFECTS FOR COBALT 60 AND 200 KV

Depth (cm.)	Cobalt 60 7 × 7 cm. Field 80 cm. S.S.D. $\mu = 0.064 \text{ cm.}^{-1}$			200 kv 7 × 7 cm. Field 50 cm. F.S.D. $\mu = 0.187 \text{ cm.}^{-1}$		
	(1) $e^{-\mu(d-0.5)}$ $(80.5 + d)^2$	(2) (1) × Scatter Factor	(3) Johns' Depth Dose	(4) $e^{-\mu d}$ $(50 + d)^2$	(5) (4) × Scatter Factor	(6) Johns' Depth Dose
	Per Cent of Maximum			Per Cent of Surface		
5	67.5	78.3	76.9	32.5	61.1	61.1
10	43.4	54.2	53.2	10.7	26.4	27.8
15	28.5	37.3	36.4	3.6	11.2	12.2
20	18.6	25.8	25.0	1.2	4.7	5.4

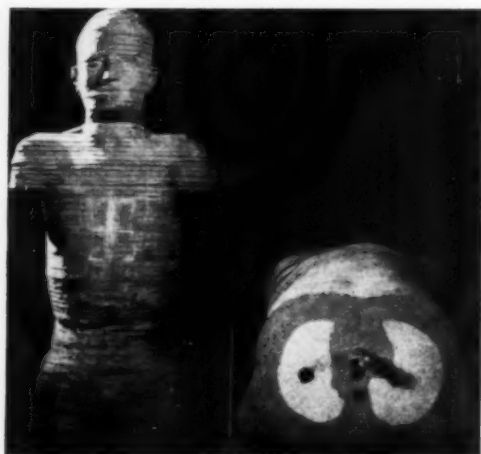


Fig. 11. Phantom man and cross section at level of the center of the field. Chamber inserted in the hole at the left.

difference in effective atomic number, Z , accounts for this in this long-wave-length region. For spongy bone and lung the ratio increases below 200 kv.

If one carries the analysis of Figure 10 to its logical conclusion, voltages below 400 kv should be used to treat tissues underlying fatty tissue in order to get a better differential in the absorption between muscle and fat. However, other factors such as scatter and depth dose have to be taken into account in treating at a depth.

With the exception of bone, the absorption values were obtained on frozen tissues of beef. There is a slight difference in density between the frozen tissue and

normal tissue. According to Failla (1), human tissues and beef do not differ greatly in absorption except for fat. In fat, absorption is greater in beef.

Calculation of Depth Dose from Absorption Coefficients: In order to see whether the coefficients of linear absorption might be of any practical use, depth doses were calculated and compared with published measured values. The dose in muscle at a given depth was calculated by using the linear coefficient of absorption for a field of 2 cm. diameter or a so-called zero area and allowing for the inverse-square-law effect and scattering. The scatter factor at a given depth was obtained by finding the ratio of the depth dose for the required field size to the depth dose for zero field. In Table IX depth doses so calculated for muscle and a field of 7 × 7 cm. are compared with published depth dose data of Johns (18). The agreement is very good for cobalt 60 and good for 200 kv except for depths of 15 cm. and more. Of course, to obtain the scatter factor one must know the depth dose before one begins.

A Presdwood phantom man with cork lungs having a density of 0.27 gm./c.c., made according to the anatomical cross section, was used to measure the dose in the "lungs" and the exit dose. The phantom and the cross section used are shown in Figure 11. The measurements were compared with the calculated values for cobalt 60, the calculations being made

as follows: The dose at the surface of the phantom was found for a field of 7×7 cm. The dose at the Presdwood cork interface, a depth of 4 cm., was determined from depth-dose charts. The depth dose 5.7 cm. within the cork was calculated, using μ for lung and a field size of 7×7 cm. A correction was made for the inverse-square-law effect but not for scattering. The calculated result was 14.4 r/min. The measured value was 14.6 r/min. Because of the low density of lung, the scattering is much lower than for muscle and may be neglected for depths which are not too great. The depth dose as found from water depth-dose charts gave a value of 12.0 r/min., 17 per cent too low.

The calculated dose near the exit interface between the cork and the Presdwood at a depth of 12 cm. in the cork was 11.2 r/min. The dose from water depth-dose charts was 7.4 r/min., a difference of 34 per cent.

The exit dose was obtained by using the dose at the exit interface between the cork and the Presdwood calculated as above. The depth dose at the exit 4.5 cm. below in Presdwood was found as a percentage of the interface dose from depth dose charts for these two distances, in this case 22.4 per cent for a distance of 101.2 cm. and 32.0 per cent for a distance of 96.7 cm. The calculated value was 7.8 r/min. The measured value was 7.9 r/min.

Whether this method of calculation holds for 200 kv remains to be investigated. However, doses in lung, except when given through the mediastinal region, should take account of the difference in absorption between lung and muscle, a difference of between 15 and 35 per cent.

SUMMARY

1. The literature on absorption of radiation in tissue is reviewed.
2. The absorption by muscle, fat, lung, compact bone, and spongy bone of beef was measured for roentgen ray generators of 100 kv, h.v.l. 1 mm. Al, for 200 kv, 0.9 mm. Cu, for 400 kv, 4.9 mm. Cu, and for

Co 60 gamma radiation. The method is described. The results are plotted.

3. The h.v.l., the linear coefficient of absorption, μ , and the mass absorption coefficient, μ/ρ , are tabulated for each kilovoltage for the above tissues, for field sizes of 7×7 cm., 5×5 cm., and of 2 cm. diameter.

4. The results are compared to those of Failla (1) and Spiers (12) and are in good agreement.

5. The linear coefficient of absorption, μ , is plotted *versus* the equivalent kilovolts for the different tissues for a field 2 cm. in diameter.

6. The ratio of $\mu_{\text{tissue}}/\mu_{\text{muscle}}$ is plotted *versus* equivalent kilovolts. This shows that from 400 kv to 1,250 kv, there is little change in the differential absorption between muscle and the tissue. Below 200 kv the absorption in bone and lung increases faster than the absorption in muscle, giving a larger ratio. The absorption in fat increases more slowly than in muscle, giving a smaller ratio.

7. Since the absorption in lung is about one-third that in muscle, ordinary depth dose values do not hold for treating lung lesions. A method of calculating the dose in lung with use of the linear absorption coefficient is described.

NOTE: We wish to thank Dr. J. R. Freid for his continued interest in this investigation, Mr. George Ross for his help in drawing the curves, and Mr. George Demuth for his patient slicing of tissues.

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SUMARIO

Absorción en Distintos Tejidos del Cobalto-60, de la Radiación Gamma y de los Rayos X con Capas de Hemirreducción que Variaban de 1.0 mm. de Al a 5 mm. de Cu

Describe un método par medir la absorción de haces pequeños y anchos en espesores determinados exactamente de músculo, tejido adiposo, pulmón y hueso. Se usaron rayos X procedentes de generadores de 100 kv, 200 kv y 400 kv con capas de hemirreducción que variaban de 1 mm. de Al a 5 mm. de Cu y radiación gamma procedente de un haz de cobalto-60 en un aparato de terapéutica. Trázanse, tabú-

lanse y compáranse con cifras teóricas y publicadas los resultados de esas mediciones. Como la absorción en el pulmón es aproximadamente la tercera parte que en el músculo, los valores ordinarios de dosis profunda no rezan con el tratamiento de las lesiones pulmonares. Describe un método para calcular la dosis en el pulmón, usando el coeficiente de absorción lineal.

DISCUSSION

Frank E. Hoecker, Ph.D. (Lawrence, Kans.): I am impressed by the painstaking experimental measurements which have gone into these investigations. One can hardly over-estimate the importance of basic measurements which can serve as the foundation for improvements in radiation therapy dosage procedures. It is evident that the authors of this paper have given much thought to the need for careful determination of the absorption of various radiations in the body tissues.

Having such dependable data at hand, one naturally is concerned with their interpretation and immediate application to therapy. Conclusions which can be drawn from these data are similar to those arrived at on the basis of Spiers' evaluations of energy absorption in bone. Comparison of results shows agreement in some instances but also brings up differences of as much as 30 per cent or more. These differences may be due to the heterogeneous radiation in the present experiment as contrasted

with the use of monochromatic radiation selected by means of Ross filters by Spiers.

One naturally speculates on the significance of the lower energy absorption in spongy bone as compared with that in compact bone and wonders about the possibility of being misled into thinking that larger doses might be delivered to tissue areas which include spongy bone. It seems that it must be borne in mind that spongy bone is made up of very small soft tissue elements, each of which is surrounded with trabeculae which in themselves are just as dense, and consequently would absorb radiation to the same extent, as compact bone. If this is so, then the interface associated with each osseous element will receive the same tissue dose as the corresponding interface on compact bone when the elements are thick enough to establish electron equilibrium.

I am unable to comprehend completely the sig-

nificance of the manner in which the ratio of the coefficient of absorption in bone to the coefficient of absorption in muscle is plotted *versus* the equivalent kilovolts. When the kv. factor, or equivalent, is arrived at by using a half-value layer to determine an equivalent wave length which is then inserted in the expression relating minimum wave length to maximum applied voltage, I must confess that I am left in doubt as to the role played by equivalent

voltage. I am sure that the authors did not mean to imply that the energy absorption processes would be the same as they would have been had the radiation been truly monochromatic. I also am wary of any graphical plot of physical data in which the curve executes a sharp discontinuity as shown by the bone curves in Figure 10. Perhaps the authors did not mean to imply the constancy over the range in which the straight lines are shown.



Body-Section Cholangiography with a New Intravenous Medium (Cholografin)¹

A. L. L. BELL, M.D., LEWIS L. IMMERMAN, M.D., and JOSEPH ARCOMANO, M.D.

BODY-SECTION radiography has been employed as an adjunct to visceral radiography by many workers. In the recent literature such a combination has been reported with various procedures utilizing contrast substances (1-4).

tine in intravenous cholangiographic studies at the Long Island College Hospital.

PROCEDURE

The examination is performed on the planigraphic table so that, as the concen-



Fig. 1. Intravenous cholangiogram, suggesting a non-opaque calculus in the distal common bile duct.

Fig. 2. Body-section cholangiogram, demonstrating a normal common bile duct.

In the course of investigations with a new cholecystographic agent, "Cholografin" (Squibb), it became apparent that the presence of confusing shadows in the right upper abdomen, produced by overlying feces and gas, could be eliminated by the use of body-section techniques. Body-section cholangiograms illustrating this effect have been exhibited (5, 6), and the procedure was mentioned in an earlier publication (7). Results in early cases proved so favorable that planigraphy became rou-

tration within the duct system approaches maximum, usually at forty minutes or thereabout, planigraphy of the right upper quadrant is begun. Since the common bile duct lies approximately in the mid-coronal plane, a starting point corresponding to this is chosen. Films are then made at 1 cm. intervals from this point until maximum definition of the duct system is obtained. For example, in the planigraphy of a patient in whom the anteroposterior diameter of the right upper

¹ From the Department of Radiology, Long Island College Hospital, Brooklyn, N. Y. Accepted for publication in November 1954.



Fig. 3. Intravenous cholangiogram; poor definition of the duct system.

Fig. 4. Body-section cholangiogram. Intrahepatic and extrahepatic biliary radicles are well defined.



Fig. 5. Intravenous cholangiogram. Overlying bowel densities obscure the distal common bile duct.

Fig. 6. Body-section cholangiogram, revealing a large faceted stone in the distal common bile duct.



Fig. 7. Intravenous cholangiogram. Poor definition of hepatodochojunostomy.
 Fig. 8. Body-section cholangiogram, clearly demonstrating the hepatodochojunostomy. The radiolucent defect represents a residual septum between intrahepatic ducts.



Fig. 9. Intravenous cholecystogram. Only the common bile duct is seen. Tantalum mesh is demonstrated in the anterior abdominal wall.
 Fig. 10. Body-section cholangiogram. The cystic duct is demonstrated and is shown to be displaced by a mass which also displaces the common bile duct. Inoperable carcinoma was found in this area on surgical exploration.

quadrant at the midclavicular line is 20 cm., sections would be obtained at 9, 10, and 11 cm. from the table top.

When plain films show the right posterior oblique projection to be the best for demonstration of the duct system, the same formula, *i.e.*, one-half the anteroposterior diameter of the right upper quadrant, will suffice as a starting point, with sections progressing anteriorly at 1-cm. intervals until optimum duct definition is attained.

Regardless of the projection used, anteroposterior or right posterior oblique, 3 to 4 sections will usually suffice to delineate the duct system. Utilizing these methods, we have been able to standardize a technic comprising an average eight or nine exposures, including a preliminary film and body-section films.

This combination of body-section radiography with intravenous cholangiography has been used in over 50 postcholecystectomy cases. Its advantages are as follows:

1. Elimination of overlying opaque and non-opaque densities which may be confused with an intraluminal filling defect (Figs. 1 and 2).
2. Demonstration of the intrahepatic and extrahepatic biliary ducts when the concentration of the contrast medium within the duct is poor (Figs. 3 and 4).
3. Conclusive demonstration of the presence of calculi within the duct system (Figs. 5 and 6).
4. Demonstration of the anatomy when

surgical procedures on the biliary tract have altered the normal appearance (Figs. 7-10).

SUMMARY

The employment of body-section radiography in intravenous cholangiography, mentioned in earlier reports, is more fully described. It is our opinion that when such technics are available to the radiologist, they should be used routinely whenever intravenous cholangiography is performed.

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SUMARIO

La Colangiografía Seccional Usando un Nuevo Medio de Contraste

Describese el uso de la radiografía de secciones del cuerpo en la colangiografía intravenosa. En el transcurso de una investigación con una nueva preparación colecistográfica, "Colografín," pareció que con el empleo de dichas técnicas podían eliminarse de la porción superior derecha del abdomen sombras confusas provocadas

por las heces y el gas sobreyacentes. Las ventajas del procedimiento aparecen en los grabados adjuntos. Deducen los AA. que, cuando el radiólogo tiene a su disposición técnicas de radiografía seccional, debe usarlas sistemáticamente siempre que se lleve a cabo la colangiografía intravenosa.

Pneumatosis Cystoides Intestinalis

With a Case Report¹

ANDREW R. McGEE, M.D., STUART F. PENNY, M.D., and NORVAL L. WILLIAMSON, M.D.

PNEUMATOSIS cystoides intestinalis is a disease occurring rarely in man but identified somewhat more frequently in animals, particularly swine. Other names applied to the condition include intestinal emphysema, peritoneal pneumatosis, pneumatosis cystoides intestinorum, and gas cysts of the abdomen.

An extensive survey of the literature by Schorr, Ullmann, and Laufer (1) indicates that DuVernoy, in 1738, was the first to describe this disorder, which he perceived while dissecting a cadaver, that Cloquet reported a case in 1820, and that Bang in 1876 wrote of a similar finding at autopsy. In spite of this early recognition, there is a paucity of recorded cases, about 250 in the world literature, of which some 50 are in the English language. Finney (2) described the first American case in 1908. More recently (1952-53) cases were published by Sherwin and Messe (3) and by Appleby (4). In 1949, Gazin, Brooke, Lerner, and Price (5) reported the first preoperative x-ray diagnosis. In 1950, Morgan and Barg (6) resected the ascending colon of a patient because of a thickening discovered at operation. Microscopic examination showed the cellular formation to be of the type that is under consideration in this paper. Parsons and Parsons, in 1948 (7), described a recurrence in the terminal ileum seven years after a radical jejunectomy for cystic intestinal pneumatosis.

PATHOLOGY

The main characteristic of pneumatosis cystoides intestinalis is the presence of single or multiple gas-filled cysts of various sizes, up to several centimeters in diameter. These sacs are often arranged in grape-like clusters but may also occur singly. They are most often located in the small bowel, less frequently in the large, and quite rarely

in the stomach or omentum. They may be situated in the submucosa or in the subserosa. The contents consist of an odorless, non-inflammable gas and, infrequently, some clear fluid. According to MacKenzie (8), chemical analysis of the gas shows 70 to 90 per cent nitrogen, 10 to 15 per cent carbon dioxide, and 3 to 20 per cent oxygen. The composition thus differs markedly from that of intestinal gas.

Though the greater number of patients have been adults, MacKenzie reported 12 cases (proved at autopsy) in children between twelve days and twelve months of age, as well as 1 in a boy of six. She was able to find in the literature an additional 32 cases occurring in childhood.

Microscopically, the intestinal mucosa appears superficially normal and unbroken, with gas-containing submucosal or subserosal sacs, lined with endothelium and containing some giant cells. The gas cannot be manually expressed from one cyst to another.

PATHOGENESIS

Pneumatosis cystoides intestinalis has been thought to occur most frequently in patients in poor physical condition. Some authors suggest that this is a predisposing factor. Increasing the nutritional status has not, however, cured the disease or limited its progress. Congenital or acquired intestinal disease is also thought to play a causative role. The suggestion of a particular bacterial or infectious origin is unproved, and without scientific factual basis. The neoplastic theory is likewise untenable. The idea of a mechanical obstruction by which, it is suggested, gas is forced under pressure through mucosal abrasions or ulcers is supported by the experimental work of Tung and Ngai (9) on dogs. Some writers suggest a relationship between the

¹ From Toronto East General and Orthopedic Hospital. Accepted for publication in November 1954.

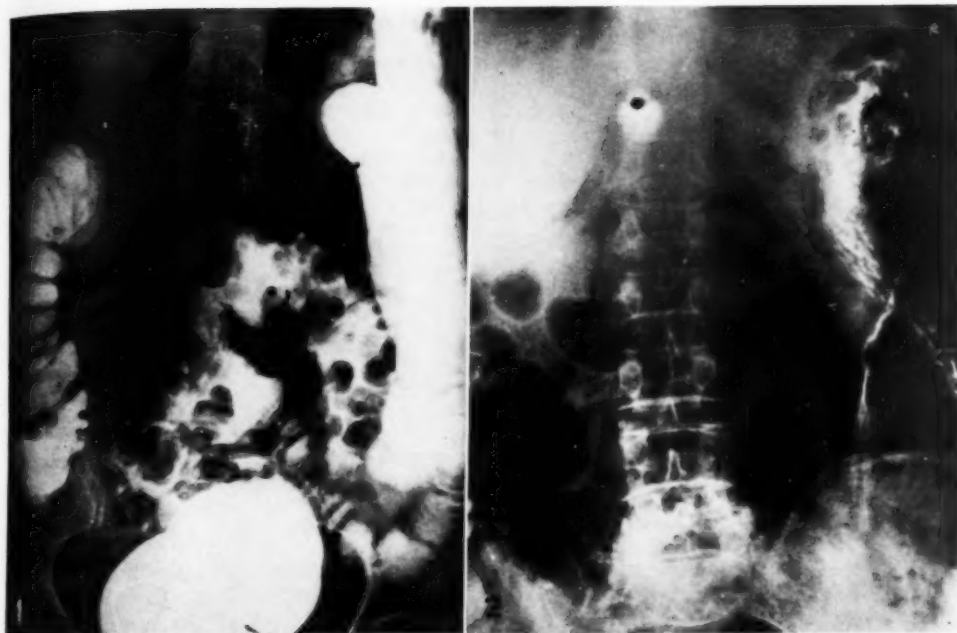


Fig. 1. Extensive gaseous sacculi of the sigmoid colon.

Fig. 2. Postoperative view, showing gas sacs in splenic flexure section. The sigmoid area is clear.

cysts and the lymphatic channels and infer that gas enters and becomes pocketed at certain levels. Autopsies, however, reveal no mucosal interruptions or points of gas entry, nor is it readily explained why the gas is not absorbed and the cysts emptied. The etiology and pathology are thus in almost the same state of confusion that characterized the thinking of writers of two hundred years ago.

CLINICAL FINDINGS

Pneumatosis cystoides intestinalis is often recognized incidentally or at autopsy. It may, however, be related to or associated with ulcer, obstruction, or other disease process in the intestine. Obstruction of the bowel may occur at the level of greatest involvement and, less frequently, passage of blood from the tract may lead to investigation.

DIAGNOSIS

The roentgenographic picture is typical, and the diagnosis should be made with ease. The barium column is surrounded, for a

greater or less extent, by gas pockets, which are readily recognized. Infrequently, some of these may perforate and empty into the peritoneal cavity, causing a pneumoperitoneum. With sufficient amounts of gas, a large subdiaphragmatic collection may result.

TREATMENT

If the cysts are localized to a fairly small section of bowel, surgical removal is indicated, and if a concomitant bowel obstruction is present, this is corrected. In many instances, however, the disease is too extensive for surgical correction. A medico-dietary régime has not proved curative.

CASE HISTORY

M. R., a female aged seventy-five years, was admitted to the Toronto East General Hospital complaining of tiredness, weight loss (26 pounds in three years), intermittent rectal bleeding for three years, constipation of recent origin, and a sense of fullness associated with epigastric discomfort. She gave a history of gastric ulcer with hematemesis five years earlier.

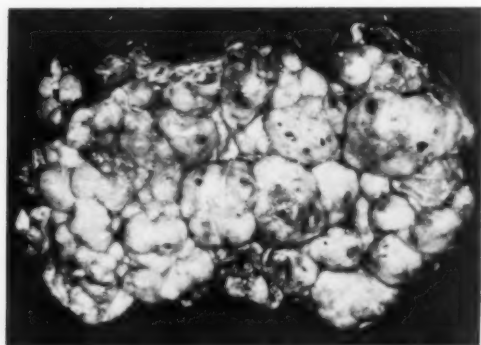


Fig. 3. Resected portion of sigmoid colon opened, showing mucosa with sessile protruding submucous cysts.



Fig. 4. Cut longitudinal section of sigmoid, revealing multiple submucous cysts with empty smooth-walled cavities.

The patient was thin, with a lax, protuberant abdomen and no palpable masses. The blood pressure was 160/80, and the pulse rate was 80.

Laboratory investigation showed the urine to be normal. Other findings were as follows: red blood cells, 3,910,000; white blood cells, 8,500; hemoglobin, 80 per cent; sedimentation rate, 5; non-protein nitrogen, 25 mg. per cent; total proteins, 8.5 per cent; albumin, 7.5 per cent; globulin, 2.8 per cent. The Wassermann reaction was negative.

Sigmoidoscopic examination disclosed the presence of multiple non-pedunculated, grape-like masses in the lower sigmoid which, on biopsy, gave a "popping effect" and collapsed.

X-ray examination showed multiple, polypoid shadows involving particularly the sigmoid, but present also in the transverse and splenic flexures (Fig. 1). The stomach and small bowel were normal.

Surgical Report: Preoperatively the patient received a diet high in vitamins and protein and of low residue. The bowel was prepared with neomycin. At operation, examination of the peritoneal cavity was negative, except for the colon, where numerous firm, cyst-like masses were noted, extending throughout a large part of the sigmoid and apparently pro-

ducing partial obstruction of the lumen. In addition, a well localized mass was palpable in the transverse section. This involved only a part of the circumference, and on opening the overlying bowel, two cyst-like masses, each approximately 1 cm. in diameter, were found. After their excision, the colonic incision was closed.

The sigmoid lesion was treated by a restorative resection. Approximately 10 inches of the bowel was excised, and an end-to-end two-layer anastomosis was carried out.

Postoperative measures included intravenous therapy, penicillin and streptomycin intramuscularly, and Wangenstein suction. The course was satisfactory and the patient was discharged from the hospital on the eighth day. Eight months later she had improved physically. There was no constipation or rectal bleeding and the distressing feeling of

fullness had disappeared. X-ray examination revealed multiple gas sacs in the area of the splenic flexure area (Fig. 2), but none in the sigmoid or transverse colon.

Pathological Report: The postoperative specimen consisted of a section of large bowel which had been opened previously (Fig. 3). It measured 16 X 10.4 cm. and was 1.5 cm. in thickness. The mucosal surface was very irregular, showing numerous bubbles, measuring up to 2.5 cm. in diameter. These were not intercommunicating (Fig. 4). The mucosa appeared pale, but there were no gross recognizable defects. At the edge, the bubbles appeared to contain gas and collapsed when perforated. The serosal aspect of the bowel was grossly unremarkable.

On microscopic examination, the mucosa appeared normal. There was a very slight infiltration of lymphocytes in the lamina propria and a few lymph follicles were present in the immediate submucosal layer (Fig. 5). Also in the submucosa were numerous large cystic spaces lined, in places, by a flattened layer of cells having endothelial characteristics. There were scattered areas of hyperplasia of the lining epithelium, with a few multinucleated giant cells (Fig. 6). In the walls of the cysts was a

Vol. 60

In addition, in the part of the sigmoid colon, about 1 cm. in length, the

restorative resection of the bowel was performed. The anastomosis

intravenous course was followed from the time of the constipation, feeling of



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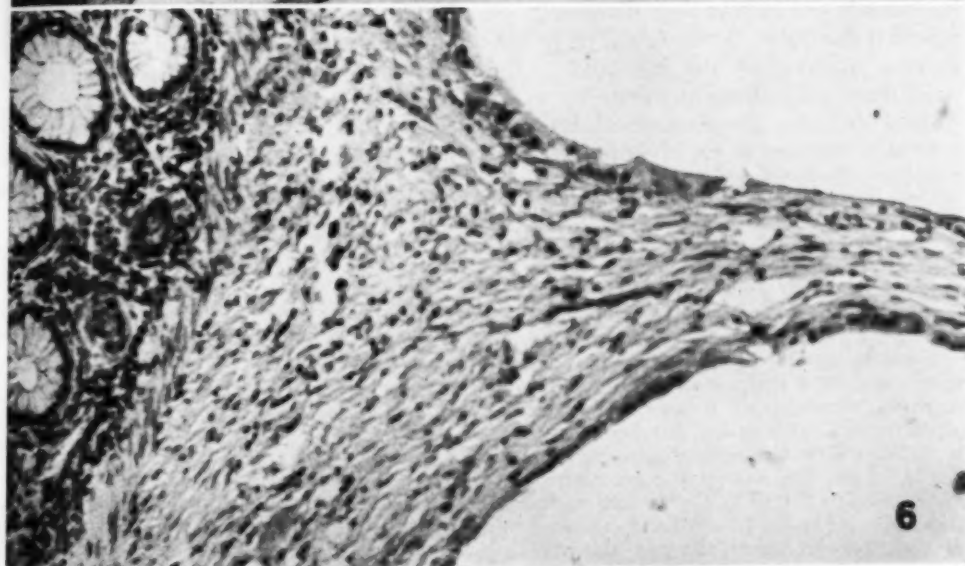


Fig. 5. Low-power photomicrograph of sigmoid colon, showing cystic cavities beneath mucosa and muscularis mucosae.

Fig. 6. Higher-power photomicrograph of cyst walls, showing lining by multinucleated giant cells and macrophages.

slight round-cell infiltration. The cyst walls were thin and composed of fibrous tissue extending into the muscularis of the bowel, but not into the serosa. There were no bacterial colonies or fungi present.

Diagnosis: Cystic pneumatosis of the colon (sigmoid).

Comment: Two of the three areas of the

diseased colon in this case were removed at operation; the third (splenic flexure section) was left. The patient's age and absence of symptoms ruled out the necessity of further intervention and favored a policy of watchful waiting.

SUMMARY

A case of pneumatosis cystoides intestinalis has been presented. Three areas of the colon were involved. The disease was most extensive at the sigmoid level. Following resection of this area, the main symptoms of hemorrhage and partial obstruction disappeared.

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SUMARIO

Pneumatosis Cystoides Intestinalis con Presentación de un Caso

Caracterízase la pneumatosis cystoides intestinalis por la presencia de quistes, ya únicos o múltiples, llenos de gas en la submucosa o subserosa del intestino. Encuéntrase más frecuentemente en el intestino delgado, a veces en el intestino grueso y raramente en el estómago y el epiplón. Descríbese un caso en una mujer de 75 años, que se quejaba de hemorragia

y síntomas indicativos de oclusión parcial. El examen radiológico reveló invasión de tres zonas del colon: la S iliaca, el colon transverso y la flexura esplénica. La afección era más extensa en la S iliaca. Después de la resección de unos 25 cms. de intestino en esta región y de la excisión de dos quistes del colon transverso, la enferma mejoró.



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Deficiency of Intestinal Gas in Infants with Diarrhea

A Presentation of Three Cases¹

ALEXANDER R. MARGULIS, M.D., FRANCES P. CONKLIN, M.D., CHARLES M. NICE, JR., M.D., and
LEO G. RIGLER, M.D.

THE PRESENCE of moderate amounts of air in the small bowel loops is a normal finding in infants. The newborn infant swallows air with its first breath, and gas can be demonstrated by roentgenograms in the sigmoid colon usually in two to five hours (6, 14, 15). Complete absence of gas in the small bowel, or in the stomach and small intestine, as shown roentgenographically, is commonly interpreted as a sign of high obstruction and of grave significance. There is little in the literature to indicate that complete absence of gas in the infant bowel occurs under any other circumstances. In 3 cases to be presented here this finding was associated with severe diarrhea and dehydration without any mechanical obstruction.

Severe diarrhea with resulting dehydration is not a true disease of infants, but rather a sign accompanying disease. In many instances it can be attributed to specific bacterial or viral causative agents (2-5, 7, 10, 13). As is well known, however, it may be due to parenteral infection elsewhere in the body, septicemia, or a host of other conditions. It is beyond the scope of this paper to delve into the causes of infantile diarrhea, nor is it necessary to emphasize its seriousness.

The roentgen findings in infants with diarrhea have not received a great deal of attention in the literature, perhaps because the physical findings are obvious and biochemical studies are the important factors in determining the therapeutic measures and following the progress of the condition. The statement that in severe infantile diarrhea the abdomen is distended and the general picture may resemble ileus is frequently encountered (1, 3, 8). Loops

of small bowel distended with gas in infants with diarrhea are commonly seen whenever abdominal films are taken in such cases.

We were not familiar, however, with the picture of a relatively gasless abdomen in this condition, and a review of the literature failed to disclose any recorded cases.

CASE REPORTS

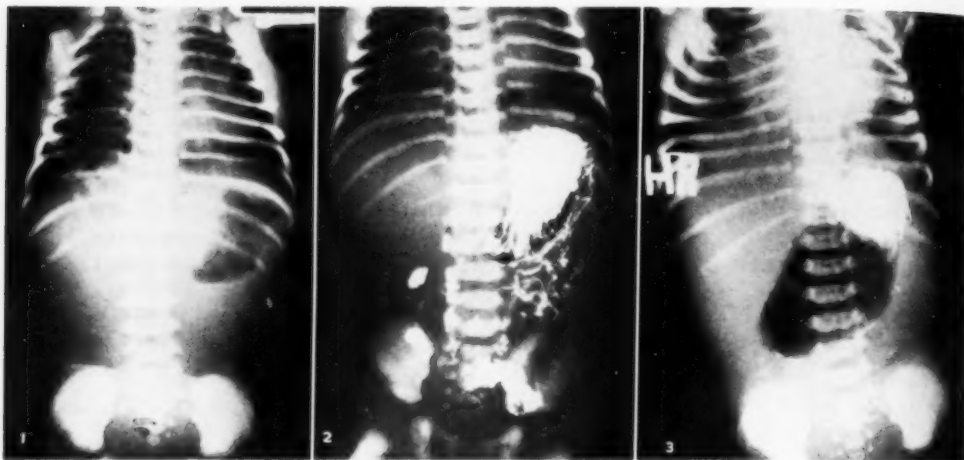
CASE I: B. F., an apparently healthy male infant, was born at the University of Minnesota Hospitals. Delivery was uncomplicated. The weight at birth was 3,620 gm.; cry and respiration were spontaneous. During the first thirty-six hours glucose and water feedings were tolerated and a meconium stool was passed. Three days after birth, however, the infant, who up to that time was taking his feedings normally, began to regurgitate all supplements and refused the breast. Two green stools were passed.

The weight had fallen to 3,170 gm., and the child showed signs of dehydration and jaundice. The abdomen was flat and soft; peristalsis was thought to be normal. A supine film revealed a small amount of gas in the stomach but none in the small or large intestine (Fig. 1). The picture was that commonly seen in pyloric stenosis or obstruction of the duodenum. A small opaque meal (Iodochlorol followed by barium) was seen to pass well into the small bowel, showing no mechanical obstruction, though passage was slow. The meal was still within the small bowel and stomach at six and a half hours (Fig. 2), and although no barium was seen in the small bowel at seventeen hours, some was still present in the stomach at that time (Fig. 3). The lumen of the small bowel at six and a half hours (Fig. 2) appeared somewhat narrower than normal.

Frequent emesis of green liquid and green mucoid stools persisted following the institution of parenteral fluid therapy. The following day excretion of the skin of the neck folds and the cheeks was noted. A colon examination was normal, as were subdural punctures. Since the child continued to vomit, an exploratory laparotomy was performed, but no positive findings were encountered. Death ensued shortly after the operation.

Autopsy showed bilateral partial atelectasis of

¹ From the Department of Radiology, University of Minnesota Hospitals, Minneapolis, Minn. Accepted for publication in December 1954.

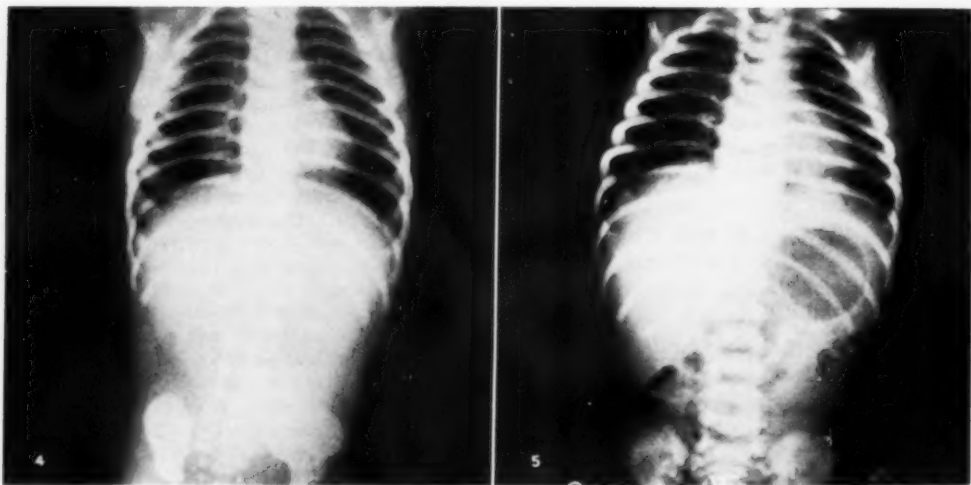


Figs. 1-3. Case I

Fig. 1. Admission film showing picture commonly associated with pyloric stenosis or high duodenal obstruction. In addition to the gas in the stomach, only a very minimal amount of gas is seen low in the pelvis.

Fig. 2. Contrast study on the same day as Fig. 1, six and a half hours after ingestion of the opaque meal. The jejunum appears narrow. The passage of the meal is slower than usual.

Fig. 3. Seventeen hours after ingestion of the contrast material. The intestinal tract shows very little gas, but the barium from the bowel was evacuated. Note that considerable residual barium is present in the fundus of the stomach. There was no evidence of obstruction.



Figs. 4 and 5. Case II

Fig. 4. Admission film taken on second day of disease, when the infant was most dehydrated. Almost no gas is seen in the stomach and none is demonstrable in the small or large bowel.

Fig. 5. Normal appearance of abdomen three weeks later. The infant fully recovered on antibiotic and parenteral fluid therapy.

the lungs, horseshoe kidneys, and an abnormal cellular activity of the glandular epithelium of the duodenum and colon, possibly a manifestation of Ritter's disease. On gross examination, the gastrointestinal tract revealed no abnormalities. Cultures of gastric contents taken on the first day of the disease disclosed alpha streptococci and coagulase-negative

staphylococci. Blood culture obtained on the second day grew out coagulase-negative staphylococci.

CASE II: R. M., a normal female infant, born at the University Hospitals, weighed 3,635 gm. at birth. Delivery was spontaneous and uncomplicated. The condition of the infant in the first forty-eight hours

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was satisfactory. On the third day, however, she started vomiting and shortly thereafter passed multiple liquid green stools. A supine film of the abdomen on the fourth day of life, one day after diarrhea and vomiting began, showed almost no gas in the stomach and none in the large or small intestine (Fig. 4). Vomiting and diarrhea persisted.

Intravenous feedings were started, and nose and throat cultures taken at this time showed coagulase-positive staphylococci. Generalized tremors, opisthotonos, and a positive Chvostek sign were not altered by intravenous administration of calcium gluconate. On the eighth day of the illness, exfoliation of the skin and two bullous lesions on the forehead were noted for the first time. Intensive antibiotic therapy was promptly instituted. Vomiting, diarrhea, and desquamation were brought under control by the twelfth day of illness, and the child was discharged completely recovered two weeks later. The weight gain was normally progressive. A supine roentgenogram of the abdomen taken three weeks following the initial film showed average amounts of intestinal gas (Fig. 5). Subsequent gastrointestinal studies were completely normal.

CASE III: K. M., an eight-month premature female infant, weighed at birth 2,136 gm. Delivery was spontaneous and uneventful. The baby was normal until breast feedings were begun on the fourth day of life. At that time she started passing frequent watery and purulent yellow stools. Diarrhea persisted in spite of five changes in formula composition, and the child was admitted to the hospital ten days later. On physical examination, a marked nasal discharge of purulent character was observed. The abdomen was soft and not distended. A supine film (Fig. 6) showed no abnormality in the chest, but definite deficiency of gas in the large and small intestine. Some air was present in the stomach and first portion of the duodenum. Material taken from nose, throat, and stools grew out an almost pure culture of *Pseudomonas aeruginosa*. The child died on the thirteenth day of illness, two days after admission to the hospital.

Autopsy showed no abnormal findings in the small bowel. The mucosa of the colon, however, was studded with superficial ulcers. The mesenteric nodes were diffusely enlarged, measuring up to 1.0 cm. in diameter.

DISCUSSION

The importance of recognizing the picture of gasless abdomen as a manifestation of diarrhea, vomiting, and dehydration, should be emphasized, and the radiologist and pediatrician who are accustomed to associating this appearance with high intestinal obstruction should be familiar with it. Such knowledge will prevent perform-

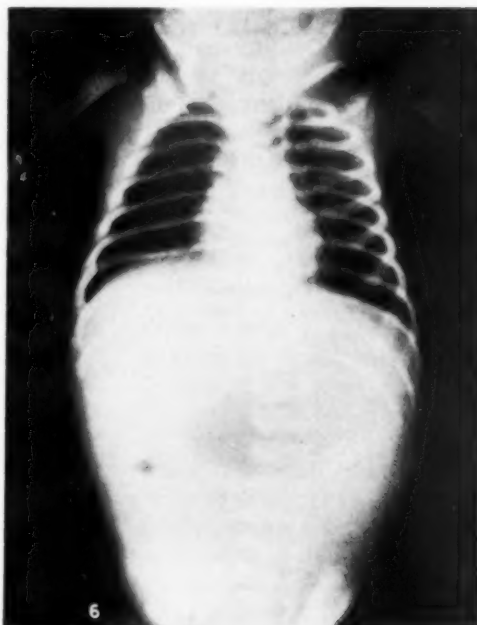


Fig. 6. Case III. Admission film on the tenth day of diarrhea. The infant was very ill and died two days later. Note that gas is definitely demonstrable only in the stomach and duodenum.

ance of unnecessary laparotomy such as was done in our first case. This is even more important in admissions through the emergency room, where a clear history of diarrhea may be lacking and vomiting may be the dominant sign. In an article to be published later we shall try to demonstrate that dehydration caused by vomiting can contribute to partial mechanical obstruction and simulate the picture of complete mechanical obstruction.

Our first 2 cases would fall into the category of Ritter's disease (9), being part of a minor outbreak in the University of Minnesota Hospitals in the summer of 1954. Although the radiologic picture in diarrhea in infants is commonly described as showing distention, which would be in accord with the physical findings, it is well known to pediatricians that the gravely ill and severely dehydrated infant will more commonly present a scaphoid abdomen (12). It can be postulated that this is probably due to collapse of the lumen of a dehydrated intestine, as is shown to a certain degree

in Case I (Fig. 2). The autopsy findings as reported in the literature (1, 4, 11) are variable, and in general the same as found in the 2 of our patients who died and were autopsied. The intestinal mucosa is either normal or shows multiple ulcerations and sometimes complete denudation. Frequently there is atony of the walls, with minute hemorrhages beneath the mucosa.

SUMMARY

Three cases of severe infantile diarrhea with dehydration, showing deficiency of intestinal gas, are presented. The importance of establishing that this finding in the presence of diarrhea does not represent high mechanical obstruction is stressed. The exact anatomic and physiologic basis for this appearance is not known, but an explanation is postulated

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SUMARIO

Falta de Gas Intestinal en los Lactantes con Diarrea. Presentación de Tres Casos

Preséntanse 3 casos de diarrea infantil grave con deshidratación, que revelaban falta relativa de gas en el abdomen. Recálcase la importancia de reconocer este cuadro de abdomen sin gas y de determinar que no representa una oclusión mecánica

alta, como la que suele asociarse con el mismo. El conocimiento de ese punto evitará una laparotomía innecesaria. No se conoce la precisa base del fenómeno. Tal vez se deba a aplastamiento de la luz de un intestino deshidratado.



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A Device for Measuring Circumferences on Roentgenograms¹

GERHART S. SCHWARZ, M.D

THE BALL METHOD of cephalopelvimetry (1, 2) requires the measurement of the circumference of the image of the fetal skull as it appears on an anteroposterior as well as on a lateral roentgenogram. A map measure has generally been used for this purpose. Snow (3) employed adhesive tape, cut into a strip, placed on the film, and shaped around the contour of the radiographic image. This method, however, is not easy and has not found general acceptance.

The map measure has the following disadvantages:

1. It cannot be used on wet film because the tracing wheel will scratch the soft gelatin layer of the emulsion, thereby making it impossible to follow the contour of the fetal skull after the first run. Also, slippage is undesirably high under these circumstances and debris of the emulsion is likely to clog the mechanism and cause corrosion. Measuring on wet film is nevertheless desirable in emergency cases.

2. There is no visible check on slippage or misguidance of the wheel after the tracing run has been completed, *i.e.*, it is impossible to be sure whether or not the instrument has slipped or run off the line once its run has been completed. It is customary, therefore, to repeat the measurement a few times and to accept that reading which recurs most often or to take the average of several readings.

3. The accuracy of the common commercially available type of this instrument is limited by the close spacing of the gradations on the dial (0.7 mm. for each centimeter measured) and by the dead play of its gears. It is impossible to measure fractions of a centimeter with such a device. This is not a serious fault when the Ball method of cephalopelvimetry is being used, since an error of 1 cm. in the measure-

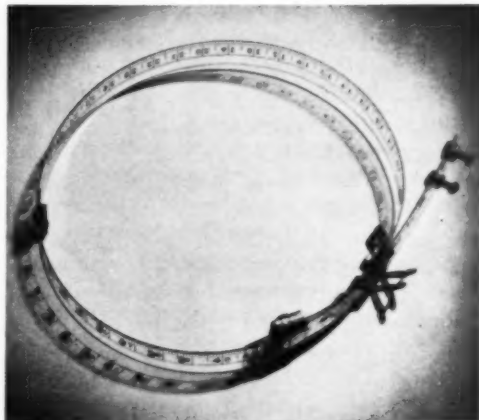


Fig. 1. View of the assembled loop.

ment of a skull circumference affects the calculated fetal head volume by only 50 c.c. The average error of between 0.5 to 1.0 cm. is acceptable but its reduction might nevertheless be welcome.

4. A map measure does not permit the determination of the largest circle that will fit into an irregularly shaped or an android pelvis.

The purpose of this communication is to describe a home-made device which overcomes the difficulties noted above. It can be assembled by anyone inclined toward home craftsmanship at a cost of less than \$1.00.

CONSTRUCTION AND OPERATION

A flexible loop resembling a hat-maker's measure (Fig. 1) is formed by bending a thin, transparent ruler of more than 50 cm. in length to form a circle. The ends are made to overlap and are held together by (a) a loose clasp which permits one end to slide along the other so as to increase and decrease the length of the loop, *i.e.*, to vary the circumference which the loop circumscribes, and (b) a spring clamp,

¹ From the Department of Radiology of the College of Physicians and Surgeons, Columbia University, and the Radiological Service of the Presbyterian Hospital, New York. Accepted for publication in November 1954.

which may be locked at any given circumference. The ruler is graduated in centimeters and millimeters. Its proximal end bears a zero mark in the shape of an arrow which can be seen through the transparent distal end and will thus point directly at that mark of the scale which represents

31 cm. to 50 cm. The sliding clasp was made by wrapping a narrow strip of tin (such as is used for edging linoleum) around both ends of the ruler and attaching it close to one end. The spring clasp was made from a pin curler and bent so as to reach over the edge of both rulers. The

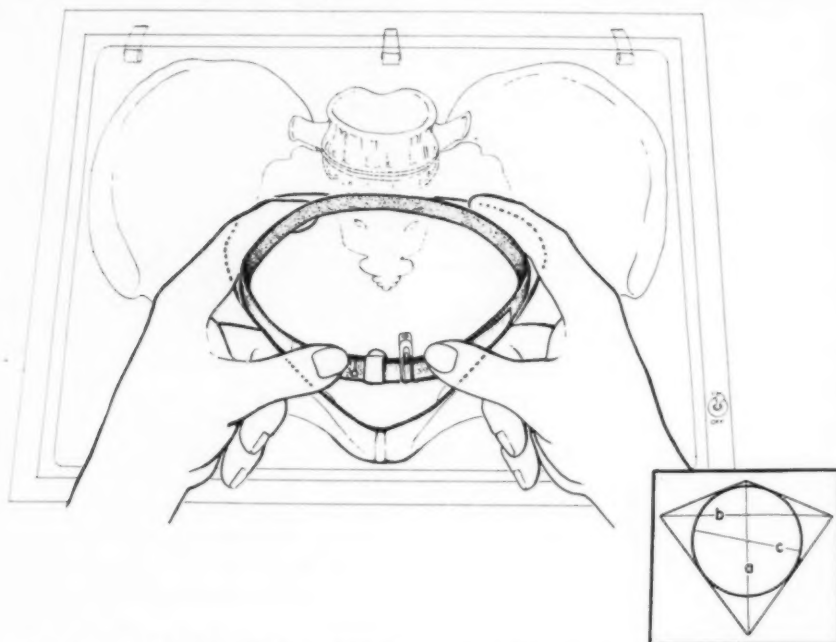


Fig. 2. Special application of the loop to an android pelvic inlet. The loop is shown as it measures the largest circumference of a circle or sphere which can pass through the inlet as it appears on a radiograph. A nomogram (5) or a special slide rule (6) converts this circumference into a figure which represents the volume capacity of the pelvic inlet as used in the Ball method of cephalopelvimetry.

Inset: Geometric demonstration of the fact that the diameter of the largest circle fitting into a deltoid outline is *smaller* than either the long or the short axis of this plane figure. Hence a circle or sphere inscribed in this deltoid is more representative of the inlet capacity than its axes.

the measured circumference. A narrow ruler, 1/2 inch in width, is preferable to a wider one, since otherwise the edge not in contact with the film will obscure the image on the film.

At the time the loop shown in Figure 1 was made, it was impossible to buy a flexible transparent ruler 50 cm. in length. Therefore two 30-cm. rulers were joined by means of two small brass screws, so that the zero mark of the second ruler was superimposed upon the 30 cm. mark of the first. The figures of the second ruler were then changed with India ink to read from

clasp was attached to the body of the ruler near one end by a brass screw. All holes necessary for the placement of screws were made by simply piercing the plastic ruler with a sharp awl. Protruding ends of screws were filed off so that they were flush with the holding nuts. The rulers were 1 inch wide and bore an inch scale along one edge and a centimeter scale along the other. They were therefore cut in half lengthwise with a pair of scissors and the strip bearing the inch scale was discarded.

List of Materials: Two Dixon No. 964 Flexible 12-inch rulers, permanently embossed, made by the

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Joseph Dixon Crucible Co., Jersey City, N. J., available in stationery and dime stores. (A single 20-inch ruler is preferred, if it can be obtained.)

Five 4/36 or 1/8-inch slotted, round-head brass machine screws, 3/8 in. long (or shorter).

Eight nuts for above.

Two washers for above.

One piece of strip metal, 2 to 3 inches long (tin or copper strip for edging linoleum).

One pin curler ("Lady Ellen Hollywood").

The fetal head as projected on the film is usually elliptical or of spheroid form. The examiner places the ruler over the shadow of the head and shapes the loop by pressure of the fingers of both hands to make it conform to the contour of the skull. Squeezing the spring clamp which holds the superimposed portions of the ruler locked permits the ends to slide on each other so that the loop may be made larger or smaller to conform exactly to the circumference of the skull shadow. When the spring clamp is released, the ruler is locked and the figure indicated by the arrow can be read without any further slipping of one end over the other.

Graduation of the ruler in millimeters permits an accuracy which is actually greater than required. On more than 100 films measured with this device, as well as with the map measure, the discrepancy was usually in the neighborhood of 0.5 cm. It did not exceed 1.0 cm. when the measurements were repeated because of a greater difference initially. This refers, however, only to cases in which both methods of measurement were used by the same examiner. When different examiners compared their measurements, greater discrepancies were observed even with a single method of measuring applied to the same film. In short, differences between individual observers were greater than differences between the two methods.

SPECIAL APPLICATION

In the Ball method, the volume capacity of the pelvic inlet is derived from its smallest diameter by calculating the volume of a sphere having a diameter of the same length. This is a logical procedure when applied to a gynecoid or platypeloid inlet.

When, however, the inlet is android and therefore fundamentally triangular or deltoid in shape, the largest circle or sphere that can pass through it has a diameter which is obviously smaller than any transverse or sagittal diameter of the inlet (Fig. 2, inset). Moloy and Steer (4) met this problem by using a set of cardboard disks, the diameter of the largest disk fitting into the inlet being accepted as its limiting dimension. In similar fashion, the flexible loop described here can be adapted to the Ball method, by fitting it into the pelvic inlet on a suitable radiograph (Thom's view or tilted anteroposterior view), as shown on Figure 2. The circumference of the largest circle capable of passing through the inlet can be read instantly on the transparent scale of the device. This circumference is then corrected for false magnification and translated into the volume of a sphere by the usual means employed in the Ball method, *i.e.*, nomogram (5) or special slide rule (6). The figure thus arrived at represents the volume capacity of the pelvic inlet and is compared with the volume of the fetal head in the manner described by Ball (1). Clinical trial of the adaptation of this particular operation to the Ball method has, up to the present, been confined to a small number of cases, but it may be pointed out that the flexible loop can be used in this manner with satisfactory results. It can probably be applied to other methods of pelvimetry as well.

SUMMARY

A device for measuring the circumference of the fetal head on a roentgen film is described. It is made of a flexible transparent plastic ruler shaped into a loop, the circumference of which can be varied until it fits the contour traced on the roentgenogram. It was designed for use in the Ball method of cephalopelvimetry.

ADDENDUM: Since the original manuscript was submitted, further experience with the loop has been gained. A review of 350 cephalopelvimetries by the Ball method uncovered 2 cases in which the special application of the loop would have prevented gross error. Out of 210 cases labeled by the

Ball method as showing no disproportion, 2 required cesarean section for inlet disproportion. In both instances, application of the loop to a modified semirecumbent Thom's view of the pelvis revealed that the capacity of the inlet was much less than its anteroposterior or transverse diameter indicated. Both pelvis were android in configuration. The mechanism shown in Figure 2 was apparently responsible for the discrepancy. Use of the loop changed the roentgenometric classification (7) from "no disproportion" to "high disproportion" in 1 case and to "borderline disproportion" in the other.

In general, the loop is now being used at the Presbyterian Hospital for all wet film readings in fetometry and cephalopelvimetry cases, while application of the map measure is confined to the interpretation of dry films.

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SUMARIO

Aparato para Medir la Circunferencia de las Radiografías

Descríbense la construcción y el funcionamiento de un aparato destinado a medir la circunferencia de las películas radiográficas. Se construye de dos reglas transparentes flexibles de un material plástico, graduadas en centímetros y milímetros, que se moldean para formar un

aro, cuya circunferencia puede variarse hasta que se ajuste al contorno trazado en la radiografía. Se diseñó con el objeto de medir cráneos de fetos, como se requería para llevar a cabo el método de céfalopelvimetría roentgenológica de Ball. La construcción es sencilla y poco costosa.



WORK IN PROGRESS*

Average Energy Expended in Producing Ion Pairs— S^{35} Absolute Value for Air¹

W. GROSS, C. WINGATE, and G. FAILLA

Application of the Bragg-Gray principle to a small air gap in a homogeneous medium with a uniform concentration of beta-ray-emitting material yields the relation:

$$W = \frac{E}{NS_0^*} \quad (1)$$

where W is the average energy expended by a beta ray in the production of an ion pair in air, E the energy emitted by the beta rays per gram of wall per second, N the number of ion pairs formed per second per gram of air, and S_0^* is the relative stopping power per gram of the medium with respect to air. A parallel-plate extrapolation type ionization chamber may be used to determine W from Eq. 1 if the radioactive material is uniformly distributed in the walls of the chamber. If the material is distributed in only one of the two chamber walls, as is expected, the ionization current is exactly halved, so that W may be measured under this condition.

We have measured W by this method, using an aqueous solution of $\text{Na}_2\text{S}^{35}\text{O}_4$ as one electrode of the extrapolation chamber. The solution thickness was greater than the maximum beta-ray range to insure that the energy emitted and absorbed per unit mass was the same. The energy emission rate was determined in a microcalorimeter (1) by Dr. W. Mann of the National Bureau of Standards, to whom we are greatly indebted. The other, collecting, electrode was a guard-ring type aluminum plate. Since this electrode is not atomically equivalent to water, experiments were performed to determine the magnitude of the change in ionization current produced by substitution of walls of different atomic composition (2). The substitution of aluminum for water results in an ionization current increase by a factor of 1.147 for the beta rays of S^{35} . The spacing was changed by varying the height of liquid. For electrode spacings of 0.6 mm. or less, the current per gram of air was found to be constant.

The value of S_0^* used was calculated from experimental data of the relative stopping power of hydrogen and oxygen to air for S^{35} beta rays (3). The value of W obtained is 33.5 ev, but it must be considered tentative, pending the experimental determination of small corrections due to the presence of water vapor in the air gap of the chamber.

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¹ From Columbia University, New York, N. Y. Based on work performed under Contract AT-30-1-GEN 70 for the Atomic Energy Commission.

Loss of Electrons from Collecting Electrode in High-Energy Photon Beams Investigated with a Double Extrapolation Chamber¹

ELIZABETH F. FOCHT, B.A., and MARY LOUISE MEURK, B.A.

In the course of taking readings on surface dose (1) with the high-energy photons of cobalt and betatron radiations, it was found that the measurement with positive saturation potential on a parallel-plate ionization chamber was considerably greater than that with negative. A similar effect has been reported (2) for cobalt. Failla (3), in 1937, called attention to the problem.

In the present case, the difference between the two measurements becomes less as the thickness of the upper electrode is increased, vanishing at the equilibrium thickness for cobalt. With the betatron there is a slight reversal at this point, the reading with negative potential on the upper electrode becoming slightly greater than with positive.

A double extrapolation chamber was designed in which the lower plate was made of a conducting plastic which could be increased in thickness, while the upper plate was increased in the usual way. For a thin upper electrode, the difference between positive and negative readings became greater as the conducting thickness of the lower plate increased. This is due to the fact that the photon beam emits electrons from the conducting portions of the collecting electrode. These are not compensated for by electrons from above in the build-up region, and the measuring electrode sees a net positive charge.

For an equilibrium thickness of upper plate, the reversal effect for the betatron was found for any thickness of the lower plate. Under these conditions the collecting electrode is at a depth of at least 4 cm. At this depth the photon flux which causes the emission of electrons from the collector is less, due to inverse-square law and absorption, than the summation of the flux above it which is contributing the

* The papers presented here were submitted for publication in November 1955 and were read at the Forty-first Annual Meeting of the Radiological Society of North America (Section C), Dec. 14, 1955.

electrons. More are therefore supplied than are lost from the conducting portion of the collector. This would be a very small effect for cobalt, as the contributing electrons are produced throughout a region of about 3 mm., in which the photon flux does not change much.

These effects occur independently of the ionization in the air volume of the chamber. This was shown by placing the thinnest upper electrode on upside down so that its non-conducting plastic surface came into contact with the lower electrode, producing an essentially airless chamber. Thicker upper electrodes were then piled on this. Such readings gave the net loss or gain of electrons in the measuring electrode directly and duplicated those made for the difference of positive and negative potentials with the air volume.

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¹ From Memorial Center, New York, N. Y.

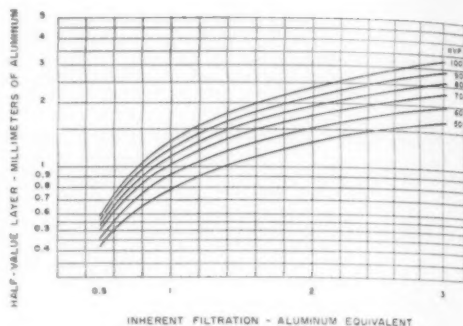
A Study of the Inherent Filtration of Diagnostic X-Ray Tubes¹

E. DALE TROUT, Sc.D., JOHN P. KELLEY, B.S., and EDWARD J. FURNO, B.S.

The use of added filtration in diagnostic techniques and the variation of inherent filtration in different types of diagnostic tubes has brought about the need for a simple procedure for determining the aluminum equivalent of the inherent filtration of the x-ray tube. Once the inherent filtration equivalent is determined, additional filter can be added to arrive at any desired total filtration. Since there will be differences in the inherent filtration of tubes of the same type and variation in the thickness of the added filters due to commercial tolerances, the accuracy of the measurement of the inherent filtration need not be of a high order.

A measurement of the half-value layer of the beam from the x-ray tube without added filter would seem to be a useful and sufficiently accurate means of determining the inherent filtration. With the aid of better low-energy instrumentation than previously available in our laboratory, and of beryllium window tubes, measurements have been made to relate inherent filtration to half-value layer.

For further relating the experimental data to the actual components going to make up the inherent filtration (glass, oil, Bakelite), a cutaway tube unit of typical component thicknesses was constructed. An x-ray beam having low filtration (2 mm. Be) was



directed through each of the elements and through the assembly to determine their influence on the resulting total filtration. Glass was found to have a transmission of 6 per cent at 80 kvp, which was reduced to 5 per cent by the addition of oil and Bakelite. From this it is evident that the glass window of the tube accounts for most of the inherent filtration.

When the beam from the 2-mm. beryllium window was filtered by directing it through the cutaway tube assembly, the half-value layer and the aluminum filtration necessary to obtain the same half-value layer at 80 kvp were: h.v.l. 0.90 mm. Al, aluminum equivalent 0.87 mm. Al. There was no significant change in the aluminum equivalent of the cutaway tube unit from 50 to 100 kvp.

All this leads to the assumption that a satisfactory value for the inherent filtration of a diagnostic tube unit can be obtained by determining the half-value layer of the unfiltered beam from the tube unit and relating this to the thickness of aluminum which must be added to a beryllium window to produce the same half-value layer under similar conditions.

¹ From General Electric Co., Milwaukee, Wisc.

Modifications of Depth Dose Curves of High Energy X-Ray and Electron Beams by Interposed Bone¹

LEWIS L. HAAS, M.D., and GLEN H. SANDBERG, B.S.

To determine by physical measurements whether interposed bone affects the standard depth dose curve of high-energy x-ray and electron beams, uniform bone plates of 0.5 and 1.0 cm. thickness were prepared by hydraulic compression of bone powder to the density of living bone and were suspended in thin plastic sheets in a water phantom. A ratio recording system was used to compare the dose rate in a stationary monitoring chamber with that of a small ionization chamber which was moved through the water phantom in step with the recorder chart motion. The chamber dimension prevented measurements closer than 0.5 cm. from the phantom surface or bone. The overall accuracy of the curves is estimated, from the close agreement of repeated measurements, to be better than 2 per cent.

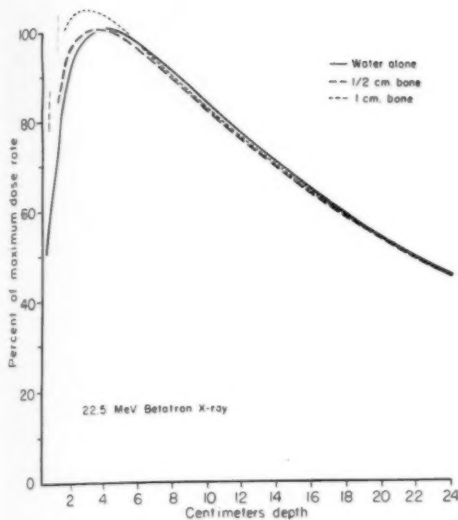


Figure 1

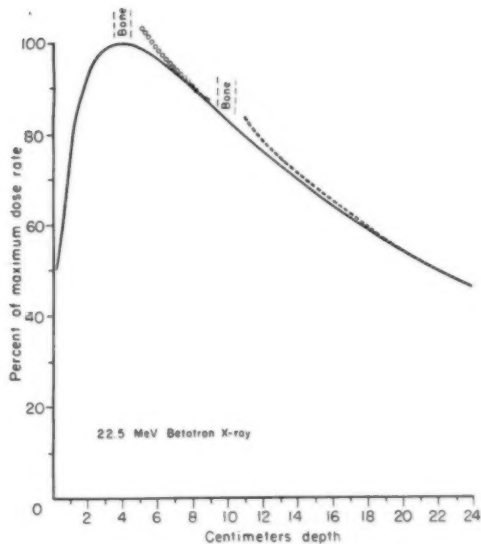


Figure 2

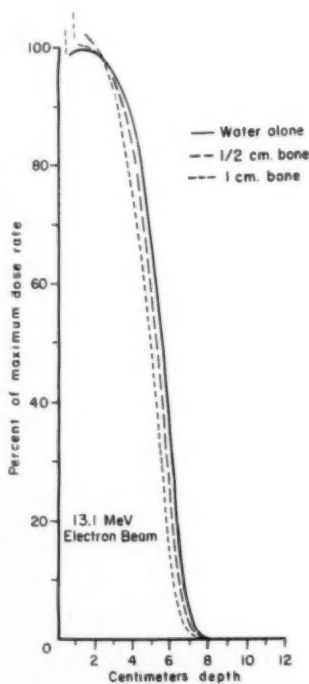


Figure 3

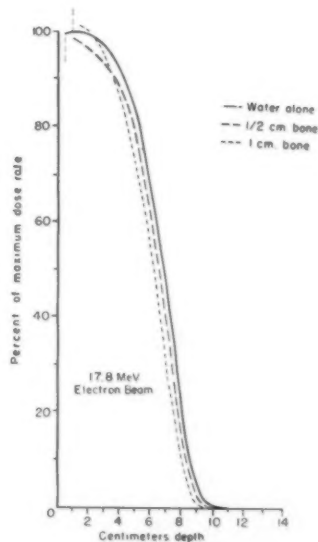


Figure 4

Figure 1 shows the comparative curves for 22.5 Mev betatron x-rays with 0, 0.5, and 1.0 cm. bone at the front of the phantom. A significant increase in dose rate and acceleration was observed in the build-up layer, with a maximum at about 3 cm. depth instead of the usual 4.0 cm. At depths beyond the build-up area the difference was insignificant, less than our 2 per cent estimated accuracy.

Figure 2 shows the effect of 1.0 cm. bone interposed at depths beyond the build-up layer. Insignificant back-scattering and a pronounced dose increase up to 2 cm. beyond the bone were observed. These effects might be explained by the greater density and higher average atomic number of bone as compared with water.

The curves for 13.1- and 17.8-Mev electron beams (Figs. 3 and 4) show that the range of penetration of both was shortened approximately 3 mm. by 0.5 cm., and 6 mm. by 1.0 cm. bone. A moderately increased build-up area also was seen after passage through bone. The shortened penetration is presumably due to higher Coulomb scattering cross section, and the increased build-up layer to increased x-ray production by the heavier bone.

These modifications of the depth dose curves of high-energy radiations by interposed bone may explain some of our unsatisfactory results and unexpected skin and mucosal reactions and should be considered in treatment planning to deliver a maximal tumor dose in the presence of interposed bone.

¹ From The College of Medicine, University of Illinois, Chicago, Ill.

Possibility of Using Thulium 170 as a Teleradiographic Source for Localization Purposes in Teletherapy with Cobalt 60¹

WARREN K. SINCLAIR, Ph.D.,
and BETSY J. SMITH, B.A.

Thulium 170 has been used as a radiographic source by Mayneord for internal radiography and for radiography of the extremities, and teleradiographic units using thulium 170 have been developed by the Argonne National Laboratory. In general, radiographs thus obtained are likely to be inferior in quality to those produced by standard equipment, and consequently thulium 170 might be expected to have few uses in a hospital. There is at least one phase of therapy, however, in which an isotope source may be valuable, *i.e.*, for localization purposes in teletherapy with cobalt 60.

One of the outstanding problems in the practical use of cobalt 60 teletherapy is the difficulty of obtaining good localization films because of lack of contrast between bone and soft tissue. Portable radiographic units can be employed for the purpose, but the difficulty of duplicating the set-up does not encourage

their use and it is more common practice to depend upon the poorer quality cobalt-60 films.

The use of a highly active teleradiographic thulium-170 source, preferably located in the head of the teletherapy unit, would obviate this difficulty if a satisfactory radiograph of body parts could be obtained with thulium-170 radiation in a reasonable time.

A thulium-170 source (4 mm. in diameter) contained in a shielding head was obtained on loan from Argonne National Laboratory. Absorption and spectroscopic measurements on this source indicated the presence of radiation harder than that usually ascribed to thulium 170. The film, however, will be mainly affected by the softer components of the radiation beam, and actual radiographs have shown that the effect on the film is similar, though not exactly the same, as that of radiation excited at about 100 kv. Films taken of chest and pelvis with the thulium-170 source were very much more satisfactory than corresponding films taken with cobalt 60 but required long exposure times.

A larger thulium-170 source (2 cm. square or 2 cm. circular), duplicating a cobalt-60 source, would require shorter exposure times and would still provide reasonable radiographs.

It is feasible to consider the fabrication of a source 2 cm. in diameter and 1 mm. thick which could be irradiated to 500 c./gm. (total activity about 1,200 curies). This source could be located in the teletherapy head and an on-off mechanism provided. This would make possible the taking of radiographs of reasonable quality in less than a minute, with only a small skin dose.

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¹ From the University of Texas M. D. Anderson Hospital and Tumor Institute, Houston, Texas.

The Gamma-Ray Spectrum of Normal Human Beings¹

C. E. MILLER, Ph.D., and L. D. MARINELLI, M.A.

The gamma-ray scintillation spectra of 20 normal, healthy human beings have been obtained with a NaI crystal in a low-level background room. Since naturally occurring K constitutes approximately 0.24 per cent of the lean body weight, and 0.112 per cent of K is K⁴⁰, the bulk of the spectrum in uncontaminated persons is due to this element. Thus a typical 70-kg. man has a body burden of about 10⁻⁷

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μ of beta activity and 10^{-8} μ of gamma activity. In order to identify less abundant isotopes present, of gamma ray energies less than 1.6 Mev, the pure K^{40} spectrum must be determined for the subject in question. This can be accomplished by giving the person a known amount of K^{42} and determining its *in vivo* spectrum after allowing about twenty-four hours for equilibrium to prevail within the body. Since the gamma energies emitted by the two isotopes are very similar, the two spectra, when normalized at about 1 Mev, coincide in the lower region. The difference between the actual spectrum and the normalized K^{42} spectrum is the net spectrum of any additional isotope present.

If the isotope emits a gamma ray whose energy is above 1.6 Mev, then the lower detectable limit is set only by the stability of the background of the room, and the accuracy with which it is to be measured in a specified time. The K content of the subject need not be known.

By these means, traces ($\sim 10^{-8}$ C) of a single 640-675 Kev gamma emitter have been found in several otherwise uncontaminated people, and work is progressing on its identification.

¹ From Argonne National Laboratory, Lemont, Ill. Work performed under the auspices of the Atomic Energy Commission.

Limitations of the Concept of Linear Energy Transfer (LET)¹

H. H. ROSSI and W. ROSENZWEIG

Variations in the relative biological effectiveness of ionizing radiations are commonly attributed to differences in specific ionization or linear energy transfer (LET). The implication has been that for each radiation field there exists *one* definite distribution of dose in LET (LET spectrum) that may be computed from an analysis of the existent particle energies and corresponding values of specific energy loss. Thus Boag (1) has furnished LET spectra in water for neutrons of various energies.

We have designed a proportional counter instrument (2) for the experimental determination of LET spectra and performed measurements (3) that show a certain discrepancy with Boag's computations. Recent experiments indicate, moreover, that the LET spectrum recorded by the instrument depends on the internal gas pressure, which implies a change of LET spectrum with change of the length of track that is sampled. We believe that this effect is real and is caused by the existence of statistical fluctuations that must affect biological systems as much as the physical measuring device.

Computations exist that provide a theoretical value of $-(dE/dx)$, the specific energy loss of a particle of given charge and speed. This representation, however, is an idealization, since in reality the

charged particle loses energy discontinuously and hence the energy ΔE lost in traversing a thickness Δx will fluctuate because of variations in both the number of collisions and the energy expended per collision. Thus, the real quantity $-(\Delta E/\Delta x)$ has a range of values for identical particles of the same energy, and the spread becomes wider as Δx is decreased, since statistical variations are larger in smaller samples. On the other hand, if Δx is increased, the spread becomes less, but since a greater number of collisions is involved, ΔE is larger and the energy of the particle may change sufficiently so that the *average* value of $-(\Delta E/\Delta x)$ obtained in the sample may differ.

For example, the theoretical value of $-(dE/dx)$ for a proton at the peak of the Bragg curve is about 91 Kev/ μ . When a small section of proton track is examined, a distribution of values will be observed which has the above figure as a mean value. As the test interval is increased, the distribution curve will become more peaked but the mean value will drop below 91 Kev/ μ .

Our experimental data indicate that, in the case of LET spectra produced by neutrons, these effects are sufficiently marked that appreciable deviations from the theoretical distribution must occur, no matter what sample is chosen. The further conclusion must be drawn that the LET spectrum is a function of the size of the biological test object and is, in fact, rather different in biological structures of different dimensions.

Because of these complications, the analysis we perform to obtain the LET spectra is itself affected by second-order errors, but these should be less than the actual discrepancy between theoretical and practical distributions.

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¹ From the Radiological Research Laboratory, Columbia University, New York, N. Y.

Contaminant Dose from Incident Neutrons Associated with 22.5-Mev X-Rays from a Betatron¹

W. ERNST, M.A., and J. OVADIA, Ph.D.

The flux of thermal and fast neutrons present at the patient treatment position has been determined by measurements of the activity induced in rhodium foils and in sulfur. A previously published energy spectrum of fast neutrons produced by photodisinte-

gration reactions with 22 Mev Bremsstrahlung in heavy elements has been used in evaluating the activation information. There are 9×10^8 fast neutrons/cm.² and 9×10^3 thermal neutrons per roentgen in the center of the collimated and compensated betatron x-ray beam at a treatment distance of 80 cm. from the target. The fast neutron spectrum has a peak intensity at 0.8 Mev. The dose produced by thermal neutrons is completely negligible. A calculation of the fast neutron dose induced in tissue has been carried out for two typical irradiation conditions: (1) four-port irradiation of the trunk; (2) bilateral irradiation of head.

¹ From the Sloan-Kettering Institute, New York, N. Y.

Effect of X-Rays on Trace-Labeled I¹³¹-Insulin and Its Relevance to Biologic Studies with I¹³¹-Labeled Proteins¹

ROSALYN S. YALOW, Ph.D.,
and SOLOMON A. BERSON, M.D.

In vivo metabolic studies in man and animals have revealed that the major fraction of insulin-I¹³¹ is degraded with a half-time of the order of forty to sixty minutes or less following its intravenous administration (1). However, a smaller fraction, the magnitude of which varies with different lots of radioiodinated insulin, is removed from the blood stream at a much slower rate, with a half-time of six to twenty-four hours. It has also been shown by paper electrophoresis and paper chromatography that the slowly degraded moiety is bound to the serum proteins in contrast to the rapidly degraded fraction which is free of such association. Appraisal of the factors influencing the relative amounts of rapidly and slowly degraded fractions led to the conclusion that the serum protein-bound components represent alterations of the native insulin and to the suspicion that these alterations are manifestations of radiation damage to the hormone.

The present study shows that similar changes can be produced by external irradiation with x-rays, peak energy 1 Mev, at dosage levels comparable to those received by the I¹³¹ trace-labeled proteins of high specific activity which are currently being employed in many biologic investigations. Trace amounts of unaltered insulin-I¹³¹ were adsorbed to Whatman No. 3MM filter paper at the site of application. The extent of alteration was then determined from the fraction of radioactivity which migrated during electrophoretic or chromatographic separation.

The results show that, in addition to the production of I¹³¹-containing products which bind to serum proteins, I¹³¹ is also released as iodide ion following irradiation of insulin-I¹³¹. The radiation dose required for the alteration of a fixed fraction of insulin-I¹³¹ is an inverse function not only of the concentration of stable insulin but also of the concen-

tration of other substances such as purified human serum albumin or cysteine. At insulin concentrations of 30 mg. per liter, irradiation at 600 r/min. for fifteen minutes produces approximately 18 per cent alteration and at 1,800 r/min. for thirty minutes produces 75 per cent alteration. The pH of the solution is another important variable, since irradiation-induced changes are barely detectable at pH7 with dosage levels sufficient to alter almost completely the same lots of insulin-I¹³¹ by irradiation at pH3. Hydrogen peroxide, in concentrations far exceeding those produced by irradiation, had no significant effect on the insulin-I¹³¹.

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¹ From the Radioisotope Service, Veterans Administration Hospital, Bronx, N. Y.

Some Physical Considerations Governing the Choice of Internally Administered Radioisotopes for Therapy¹

M. BERMAN, J. E. RALL, and J. HESLIN

In the administration of radioactive isotopes for therapy, use is frequently made of the metabolism of the isotope by a specific type of tumor. Since the isotope is also metabolized elsewhere in the body, and since its gamma rays are fairly penetrating, other regions are also irradiated. The factor limiting the amount of radiation which can be delivered to a tumor is usually determined by the maximum permissible dose to some critical area in the body, as the bone marrow.

It is the purpose of this study to investigate the relative advantages of various isotopes from the point of view of the ratio of maximum tumor to critical region dose. The following variables are included: the metabolizing function of the isotope in the various regions, the half-life, the beta- and gamma-ray energy of the isotope, and the tumor size.

The derived expressions were applied to various iodine isotopes, and calculations were made to determine the relative advantage of these isotopes from data on 9 patients receiving therapeutic doses of I¹³¹. The calculations indicate that for most patients the iodine isotopes having a higher beta-to-gamma-ray energy ratio are more advantageous, so long as their half-life is of the order of one day or longer. It appears that I¹³¹ is probably not always the most desirable for maximal tumor and minimal critical region irradiation.

¹ From Sloan-Kettering Institute, New York, N. Y.

EDITORIAL

Arteriography in Segmental Arterial Occlusion

Opacification of the arteries for purposes of roentgen diagnosis of arterial occlusion was first practiced about thirty years ago but received less attention than its present importance would seem to call for. This is due partly to the fact that it is only in the past decade that there has been any rapid development of curative surgical procedures. The lack of a satisfactory opacifying agent also delayed progress. The opacifying material must be of high radiographic density; its introduction should be relatively painless, and it must have a high degree of safety for the patient. Diodrast 70 per cent and Urokon 50 per cent are probably the two most widely used media. That absolute safety has not been achieved is shown by published mortality rates varying from 0.38 to 1.0 per cent. Most of the solutions employed are irritating to the endothelium and cause varying degrees of discomfort.

In a recent communication Greenwald, Le Fevre, Root, and Humphries (1) state that, while the history and physical examination will disclose the presence of peripheral vascular disease, these must be supplemented by arteriography to demonstrate the site and extent of segmental occlusion. They have found femoral arteriography satisfactory, and prefer the method of arterial catheterization which was originally used for retrograde aortography. This, they believe, minimizes local trauma, lessens the danger of extravasation, and reduces the radiation hazard to the operator because of the added distance from the radiation field. They prefer 50 per cent Urokon as the opacifying agent. Their experience indicates that good results with arterial grafting are obtained only in those cases in which there

is adequate filling of the vessel distal to the area of occlusion.

One of the most brilliant chapters in surgical care in recent years is concerned with vascular surgery. The pioneer work of Carrel on vascular transplantation, at the turn of the century, long lay dormant but in recent years has come to full fruition. Ten years ago Gross (2) accomplished the first excision of coarctation of the aorta, an operation which has become a standard procedure and is now being done by most vascular surgeons. Oudot (3) four years ago performed the first resection of the bifurcation of the aorta with graft replacement, for the relief of Leriche's syndrome. A year later Charles and Claude Dubost (7) used the same procedure for aneurysm and within a few months the operation was done in America independently by De-Bakey, Bahnson, Julian, and Szilagyi. This and similar arterial excisions have now become relatively common.

Such operative procedures have created a demand for vascular replacements, such as grafts and prostheses. In spite of many problems which remain to be solved, it has now become possible to develop a practical artery bank to assure a constant supply of homologous arterial grafts. Since it is difficult to obtain graft material at autopsy under sterile conditions, some method of sterilization of the material was a practical necessity. High-voltage irradiation and chemical agents have been used for this purpose. The use of beta-propiolactone in 1 per cent solution has proved satisfactory in the hands of Szilagyi *et al.* (6).

It is now generally accepted that a homograft serves merely as a framework,

being eventually replaced by the ingrowth of host tissue. Some have feared that the new fibrous tube may eventually become calcified or undergo aneurysmal dilatation, but long grafts which have been under observation from two to four years have revealed no such degenerative changes.

A study of 27 cases of stenosis of major arteries due to arteriosclerosis has been presented by Wylie and McGuinness (4). A segmental zone of arteriosclerotic narrowing was demonstrated in 12 patients with complaints attributable to arterial insufficiency. In 6 cases the stenosis was an incidental arteriographic finding, in 6 instances the stenotic lesion had progressed to complete thrombosis, and 3 patients had stenosis apart from a zone of arterial thrombosis. In the lower aortic and iliac areas, where stenosis was found, the intima was usually involved by arteriosclerotic thickening and plaque formation. These writers suggest that the lumen of a major artery must be reduced by at least 90 per cent to produce impairment sufficient to cause ischemic symptoms.

Szilagyi and Overhulse (5) have reported a series of 27 cases of segmental arterial occlusion in the aorto-iliac and femoral areas. In 14 cases, involving 19 operative procedures, resection and homograft replacement yielded good results in 76 per cent, in the form of functionally patent grafts and relief of symptoms.

The progress which has been made in the treatment of vascular insufficiency has contributed in a large degree to the ambulation of patients suffering from this condition. In many others, it has obviated the necessity of amputation. For the pioneer work which has made these results possible, credit must be given to many radiologists and surgeons. Continued teamwork will be necessary for further advances, and in this rapidly expanding field the radiologist must be prepared to play his part.

HOWARD P. DOUB, M.D.

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Reaping the Harvest

Reaping the harvest of the medical literature of the world, or indeed the literature of one's own language or specialty, is far too extensive a task for even the genius, let alone thee and me. Some ten years of abstracting for RADIOLOGY has led the writer to reflect on the great service rendered by the abstract sections of the medical journals, even though these are not as widely read or generally appreciated as they should be. The necessity of dependence upon abstracts is made obvious by the present-day popularity of

various abstracting services. Yet the journals which regularly publish comprehensive abstracts are numbered.

The field of radiology knows little limitation, overlapping a wide range of specialties. Of all the practitioners of medicine, the radiologist must keep not abreast but ahead of the times. His central and referred position in medical practice makes it mandatory that he survey the new, select the useful, and replace the old and outworn.

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menous task? Shall radiology be split into diagnosis and therapy in every hamlet in the nation? No, this is not practical in a country of the texture (physical and mental) and size of ours—the small area needs the composite man. Outside the large medical centers and teaching institutions, the day-to-day practice of radiology in all its phases must remain the rule. The problem then falls upon the “general radiologist”: How can he keep himself informed of the advances in his specialty as it concerns both diagnosis and therapy in their manifold applications?

Reap the harvest—it is bountiful. Read abstracts in large numbers! To be sure, that is not of itself enough. Abstracts by their very nature must omit details; they do not engage a long-attention span. They serve, however, as an essential background for more selective reading of the literature they represent. They will create, also, a greater interest in meetings

and refresher courses and will in turn become of greater value in the light of these educational activities, which aid in keeping the mind alert, offer stimulating contacts, and afford fresh orientation. As a result, the routine job of abstract reading will receive a new emphasis when the taste for it may have waned. In other words, the chore will be taken out of it.

Lest the reader feel that the necessity for reading and “keeping-up” has been over-emphasized, let him look about and estimate the satisfaction in practice of those who do and those who don't. Display of the knowledge acquired need not immediately follow, but the man who has “kept-up” can speak with authority when the occasion arises.

SYDNEY F. THOMAS, M.D.

REFERENCE

Bull. Am. Inst. Biol. Sc. 5: January and April 1955.



ANNOUNCEMENTS AND BOOK REVIEWS

AMERICAN BOARD OF RADIOLOGY

Three examinations will be conducted by the American Board of Radiology in 1956, the first to be held in Atlanta, Ga., March 6 to 10 (deadline for filing applications Dec. 1, 1955); the second in Chicago, June 5 to 9 (deadline for applications Jan. 1), the third in Los Angeles, Sept. 30 to Oct. 4 (deadline for filing applications June 1, 1956).

LOS ANGELES RADIOLOGICAL SOCIETY

The Eighth Annual Mid-Winter Radiological Conference, sponsored by the Los Angeles Radiological Society, will be held at the Biltmore Hotel in Los Angeles, Calif., Feb. 25 and 26, 1956. Guest speakers will include: Dr. R. McWhirter, Edinburgh, Scotland; Dr. Narno Dorbecker, Mexico City; Dr. Philip Hodes, Philadelphia; Dr. David Pugh, Rochester, Minn.

General Chairman of the conference is Dr. Robert Engle, St. Luke Hospital, Pasadena. Reservations may be made through the Conference Secretary, Dr. Norval Zimmerman, 3875 Wilshire Blvd., Los Angeles 5. The Conference fee is \$20. Courtesy cards are available to radiology residents and radiologists in military service by advance registration. Hotel reservations should be made as soon as possible through the Convention Manager of the Biltmore Hotel.

COLORADO RADIOLOGICAL SOCIETY

At a meeting of the Colorado Radiological Society, Sept. 15, 1955, the following officers were elected: President, Raymond R. Lanier, M.D., Denver; Vice-President, James W. Lewis, M.D., Colorado Springs; Treasurer, Lorenz R. Wurtzebach, M.D., Denver; Secretary, Dorr H. Burns, M.D., 1776 Vine St., Denver.

NORTH CAROLINA RADIOLOGICAL SOCIETY

At the annual meeting of the North Carolina Radiological Society, held in Greensboro on Nov. 26, 1955, the following were elected to office: Dr. Ernest H. Wood, Chapel Hill, President; Dr. James S. Raper, Asheville, President-Elect; Dr. Waldemar C. A. Sternbergh, Charlotte, Vice-President; Dr. William H. Sprunt, Department of Radiology, North Carolina Memorial Hospital, Chapel Hill, Secretary-Treasurer.

NORTHEASTERN NEW YORK RADIOLOGICAL SOCIETY

At the fifth annual meeting of the Northeastern New York Radiological Society, held in 1955,

the following were elected for the ensuing year: Dr. LeRoy House, Oneonta, President; Dr. Ira Rowson, Plattsburg, Vice-President; Dr. Robert R. Wadlund, Department of Radiology, Albany Hospital, Albany, Secretary-Treasurer.

SAN FRANCISCO RADIOLOGICAL SOCIETY

The following officers have been elected by the San Francisco Radiological Society: Ivan J. Miller, M.D., President; Tom M. Fullenlove, M.D., President-Elect; Earl R. Miller, M.D., Member of the Executive Board for one year; John F. Huffman, M.D., Member of the Executive Board for two years; Howard L. Steinbach, M.D., Department of Radiology, University of California Medical Center, San Francisco 22, Secretary-Treasurer.

UTAH STATE RADIOLOGICAL SOCIETY

At the annual meeting of the Utah State Radiological Society held in November, the following officers were elected for the forthcoming year: President, Robert M. Crowder, M.D., Salt Lake City; Vice-President, Harry Brown, M.D., Provo; Secretary-Treasurer, Angus K. Wilson, M.D., 343 S. Main St., Salt Lake City.

ASSOCIATION OF UNIVERSITY RADIOLOGISTS

Current officers of the Association of University Radiologists are: President, Dr. William B. Seaman, Washington University; President-Elect, Dr. John F. Holt, University of Michigan; Secretary-Treasurer, Dr. Robert J. Bloor, University of Rochester, 260 Crittenden Blvd., Rochester 20, N. Y. The next annual meeting will be held in Rochester, N. Y., in May 1956.

SOCIETY OF NUCLEAR MEDICINE

The annual meeting of the Society of Nuclear Medicine will be held in Salt Lake City at the Hotel Utah on June 21 to 23, 1956. Present officers are: Milo Morris, M.D., Spokane, Wash., President; Norman J. Holter, Ph.D., Helena, Mont., President-Elect; R. Labbe, Ph.D., Portland, Ore., Treasurer; R. G. Moffat, M.D., 2656 Heather St., Vancouver 9, Canada, Secretary; Thomas Carlile, M.D., Seattle, Wash., Chairman of the Membership Committee.

VISITING LECTURESHIP TEXAS RADIOLOGICAL SOCIETY

A Visiting Lectureship has been sponsored by the Texas Radiological Society for the three medical

schools of Texas: University of Texas Medical School in Galveston, Baylor University College of Medicine in Houston, and the Southwestern Medical School in Dallas. Guest lecturer for the first group of lectures, to be given in January 1956, will be Dr. Franz Buschke, Seattle. His subject will be "The Role of Common Sense in Cancer Therapy." Further information concerning the date of each lecture may be obtained from R. P. O'Bannon, M.D., Fort Worth, Secretary-Treasurer, or Martin Schneider, M.D., Galveston, President.

COURSE IN THE CLINICAL USE OF RADIOACTIVE ISOTOPES

A course in the clinical use of radioactive isotopes will be given by Dr. Sergei Feitelberg of Mount Sinai Hospital, New York, and Dr. Edith H. Quimby of Columbia University, June 4 through June 29, 1956, Mondays through Fridays, 9 to 12 A.M. and 1 to 5 P.M.

This is a full-time course, including lectures, clinical rounds, and experimental laboratory exercises, as well as clinical laboratory measurements on patients and on specimens. In addition to the listed instructors, sixteen invited lecturers from the New York area will present topics in their special fields.

The lectures will cover the physics of radioactive isotopes and of interaction of radiation and matter; technic and measurements of radiation and of radioactive isotopes; the clinical use of radioactive iodine in thyroid disease; the therapeutic use of radioactive phosphorus and radioactive gold; the diagnostic use of miscellaneous isotopes (determination of blood volume, localization of brain tumors, radioactive sodium, and radioactive iron); and the organization of radioisotope work in a hospital.

Laboratory work will comprise thirteen afternoon sessions devoted to experiments on basic methods of radioisotope measurements, on technics used in clinical diagnostic work, and experience with equipment actually employed in clinical procedures.

The class is limited to fifteen; the fee for the course is \$200. Inquiries may be addressed to Dr. Edith H. Quimby, Radiological Research Laboratory, 630 West 168th St., New York 32.

INSTRUCTION IN THE CLINICAL APPLICATIONS OF RADIOISOTOPES

A course in the clinical applications of radioactive isotopes, specifically designed to accommodate radiologists who are unable to leave their responsibilities for continuous periods of several weeks, is being offered jointly by the University of Kansas and Stormont-Vail Hospital, Topeka, through the Medical Extension Division of the University. The course comprises six sessions of two days each in which laboratory and lecture instruction in the physical foundations of radiation and radioactivity,

the interaction between radiation and biological organisms, and laboratory technics in measurements of radiation and radioactive isotopes, given under the Radiation Biophysics Program at Lawrence, alternate with clinical sessions at Stormont-Vail Hospital.

Each session is limited to three physicians and the fee for the course is \$175.00. Dates may be arranged by correspondence with Dr. Frank E. Hoecker, Radiation Biophysics, University of Kansas, Lawrence, Kan.

COURSE IN DIAGNOSTIC USE OF RADIOACTIVE IODINE

Subject to receipt of sufficient registrations, a one-week intensive course in the diagnostic use of radioactive iodine has been scheduled to begin April 2, 1956, in the Isotope Laboratory at the Georgetown University Medical Center, Washington, D. C., under the direction of Benedict J. Duffy, Jr., M.D., and John R. Howley. This is a clinical didactic course, available to physicians only. Registrations should be submitted not less than two weeks prior to April 2, 1956. The fee for the course is \$100.

In addition to this basic course, an advanced section will be offered to provide specialized training and clinical experience to meet the requirements of the Atomic Energy Commission for specialized diagnostic studies and therapeutic use of radioiodine, radiophosphorus, and radiogold. This course will be provided weekly, on Fridays, from April 13 through June 29, 1956.

GOLD MEDAL OF THE AMERICAN COLLEGE OF RADIOLOGY

The Gold Medal of the American College of Radiology will be awarded to Dr. Samuel W. Donaldson, of Ann Arbor, Mich., and Dr. Eugene P. Pendergrass, Philadelphia, Penna., at ceremonies during the annual meeting of the College, Feb. 10, 1956, in Chicago.

Dr. Donaldson has long been associated with the Radiological Society of North America. He is now serving as Director of the Placement Bureau of the American College of Radiology.

Dr. Pendergrass is a past-president and Chairman of the Board of Chancellors of the American College of Radiology, and is a past-president of the Radiological Society of North America. He is at present Chairman of the Department of Radiology, University of Pennsylvania Hospital, and Professor of Radiology, University of Pennsylvania School of Medicine.

SECOND INTERNATIONAL CONGRESS OF MEDICAL RADIOPHOTOGRAPHY

The Second International Congress of Medical Radiophotography, concerned with medical, techni-

cal, and organizational aspects of radiophotography, is to be held in Paris, April 4 to 7, 1956. Information may be obtained upon request from the Secretariat, 66 Boulevard Saint-Michel, Paris 6ème.

The provisional program provides for four sections, as follows: I. Radiophotography in Pulmonary Tuberculosis. II. Radiophotography in Non-Tuberculous Diseases of the Thorax and in Its New Applications Outside Thoracic Diseases. III. Apparatus and Technics in Radiophotography. IV. The Reading and Interpretation of Radiophotographic Films.

PROFESSOR BERVEN AWARDED MEDAL OF CENTRE ANTOINE BÉCLÈRE

During the course of the *Journées nationales d'électro-radiologie médicale* in Paris, in October 1955, the medal of the Centre Antoine Bécclère was awarded to Professor Elis Berven of the Radiumhemmet, Stockholm, for his achievements in the field of radiotherapy. Dr. Berven is the fourth recipient of this honor, the others being Dr. George E. Pfahler, Professor H. Holthusen, and Professor E. Rist.

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

THE BACK AND ITS DISK SYNDROMES, INCLUDING INJURIES, DISEASES, DEFORMITIES AND DISABILITIES, WITH NOTES ON THE PELVIS AND COCCYX. By PHILIP LEWIN, M.D., F.A.C.S., F.I.C.S., Professor Emeritus and formerly Chairman of Orthopaedic Surgery, Cook County Graduate School of Medicine, Chicago; Consulting Orthopaedic Surgeon, Cook County Hospital; Senior Attending Orthopaedic Surgeon, Michael Reese Hospital, and formerly Chairman of the Department; Chief of Staff, Highwood Hospital, and Clinic, Highwood, Ill., Colonel, M.C., U.S.A. (Retired). A volume of 942 pages, with 371 figures and 4 color plates (line drawings by Harold Laufman, M.D., Associate Professor of Surgery, Northwestern University Medical School, Chicago) Published by Lea & Febiger, Philadelphia, 2d ed., thoroughly revised, 1955. Price \$18.50.

ATLAS OF BRONCHIAL LESIONS IN PULMONARY TUBERCULOSIS. A CLINICAL AND MORBID-ANATOMICAL STUDY. By C. DIJKSTRA, M.D., Medical Superintendent of the Sanatorium "De Klokkenberg," Breda, The Netherlands. A vol-

ume of 128 pages, with 131 illustrations. Published by Charles C Thomas, Springfield, Ill., 1955. Price \$11.00.

RESEARCH FILMS IN BIOLOGY, ANTHROPOLOGY, PSYCHOLOGY, AND MEDICINE. By ANTHONY R. MICHAELIS, Technical Director, Scientific, Industrial, and Medical Photographic Laboratories, Ltd., London, England. A volume of 490 pages, with 88 illustrations. Published by Academic Press Inc., New York, N. Y., 1955. Price \$10.00.

NUCLEAR RADIATION DETECTORS. By J. SHARPE, B.Sc., A.M.I.E.E., late of Atomic Energy Research Establishment, Harwell. A volume of 180 pages, with numerous graphs and tables. Published by Methuen & Co., Ltd., London, and John Wiley & Sons, Inc., New York, 1955. Price \$2.50.

SMALL-ANGLE SCATTERING OF X-RAYS. By ANDRÉ GUINIER, Professor, Université de Paris (France) and GÉRARD FOURNET, Lecturer, École Supérieure de Physique et Chimie, Paris. Translated by Christopher B. Walker, Institute for the Study of Metals, University of Chicago. Bibliography by KENNETH L. YUDOWITCH, Johns Hopkins University. A volume of 268 pages, with 78 illustrations. Published by John Wiley & Sons, Inc., New York, and Chapman & Hall, Ltd., London, 1955. Price \$7.50.

PRÉCIS DE TECHNIQUE RADIOLOGIQUE. By A. NÈGRE and F. ROUQUET, Anciens Assistants d'Électro-Radiologie du Val-de-Grâce. Preface by M. le Professeur Didiée. A book of 344 pages with 259 figures. Published by G. Doin & Cie, Paris, 3d ed., completely revised, 1955. Price 2,600 fr.

AUS- UND WEITERBILDUNG IN DER MEDIZINISCHEN STRAHLENKUNDE. REDEN UND DENKSCHRIFTEN. Published by the Deutschen Röntgengesellschaft, Gesellschaft für medizinische Strahlenkunde und Strahlenforschung E. V. A booklet of 42 pages. Published by Georg Thieme Verlag, Stuttgart, 1955. Distributed in the United States and Canada by the Intercontinental Medical Book Corporation, New York, N. Y. Price DM 3.60 (\$85).

Book Reviews

OBSTETRICAL ROENTGENOLOGY. By ROBERT BERMAN, M.D., F.A.C.S., Assistant Clinical Professor of Obstetrics and Gynecology, New York University College of Medicine, N. Y.; Attending Obstetrician and Rotating Director of Obstetrics and

Gynecology, Beth Israel Hospital, Newark, N. J.; Associate in Roentgenology, Margaret Hague Maternity Hospital, Jersey City, N. J.; Assistant Attending in Obstetrics and Gynecology, University Hospital, N. Y.; Director of Sterility Clinic, University Hospital, N. Y.; Consultant Obstetrician and Gynecologist, Irvington General Hospital, Irvington, N. J.; Diplomate, American Board of Obstetrics and Gynecology. A volume of 600 pages, with numerous illustrations including roentgenograms and diagrams. Published by the F. A. Davis Co., Philadelphia, 1955. Price \$12.50.

In this comprehensive volume the subject of obstetrical roentgenology is covered from basic x-ray theory and technics to clinical obstetrics. The text is the work of an obstetrician and emphasizes the clinician's point of view. The author's own "prognostic method," which is described at length, is a modification of the technic of Caldwell and Moloy. His film studies were made with apparatus operated at 75 to 80 kv, 50 ma, with a short target-film distance.

The material upon which the work is based included some 2,500 cases encountered in practice and was not limited to patients with abnormal clinical manifestations or indications of dystocia. A large number of roentgenograms were obtained following delivery. In 80 per cent of all pelvis in the series the measurements were ample, but in 5 per cent of this group dystocia occurred as a result of other factors, such as inertia.

This book will be primarily of interest to obstetricians. An excellent chapter on the history of roentgenologic obstetrics and an extensive bibliography provide source material for students and radiologists in this field.

PELVO-SPONDYLITIS OSSIFICANS. RHEUMATOID OR ANKYLOSING SPONDYLITIS. A ROENTGENOLOGICAL AND CLINICAL GUIDE TO ITS EARLY DIAGNOSIS (ESPECIALLY ANTERIOR SPONDYLITIS). By RAGNAR ROMANUS AND SVEN YDÉN, Karolinska Sjukhuset and King Gustaf V's Research Institute, Stockholm, Sweden. English translation by Joan Whitehouse. A volume of 162 pages, with 55 figures, including roentgenograms and schematic drawings. Published by The Year Book Publishers, Inc., Chicago, Ill., 1955. Price \$8.50.

In this valuable monograph the authors have brought together most of the accumulated knowledge concerning ankylosing spondylitis. The title introduces a new designation for a condition which already has a superabundance of names. The authors describe and illustrate the course of the disease through the various stages to the state of complete ankylosis.

The first half of the volume, devoted to description of the roentgenographic signs and the clinical

syndrome, is largely a compilation of the available knowledge on the subject without the introduction of much new material. The early involvement of the sacroiliac joints and their roentgen appearance during the various stages are given special emphasis. The calcific changes occurring about the spine and the involvement of peripheral joints are also discussed at length.

The second half of the work is made up of roentgenograms depicting the different aspects of the disease. These are printed in the positive rather than in the original negative phase. There is an excellent bibliography at the end of the text.

This is a valuable book for reference. It should be of interest to all those dealing with arthritis.

A HANDBOOK OF RADIOTHERAPY. By WALTER M. LEVITT, M.D., F.R.C.P. (Lond.), F.F.R., D.M. R. E. (Camb.) of Lincoln's Inn, Barrister-at-Law. Associate Physician to the Department of Radiotherapy, St. Bartholomew's Hospital, London; late Physician in Charge, Department of Radiotherapy, St. George's Hospital; late Examiner in Radiotherapy for the Fellowship, Faculty of Radiologists; and Lecturer in Radiotherapy for the D.M.R.E., Cambridge. A volume of 232 pages, with 53 figures. Published by Paul B. Hoeber, Inc., 49 E. 33rd St., New York 16, N. Y., 1953. Price \$6.50.

The author has prepared this small volume for the senior and postgraduate medical student. It does provide an excellent and stimulating review of the basic considerations of radiotherapy. Chapters on specific conditions give short résumés of the clinical, pathological, and therapeutic aspects. Brief mention is made of radioisotopes for thyroid carcinoma, leukemia, and polycythemia vera.

The first two chapters of the book are devoted to what the author calls the "A.B.C." of atoms, isotopes, x-rays and radium. A chapter on planning and one on the constitutional and local effects of radiation exposure of acute and chronic types follow. The effect of time and intensity factors as well as inherent cellular characteristics relating to tumor sensitivity are discussed. An important chapter is the one devoted to the general management of the patient before, during, and after radiotherapy. In general, this first portion of the book is very well done and comparable to sections dealing with the same subjects in many large textbooks.

Female breast carcinoma and carcinoma of the female genitalia receive a more detailed appraisal than one would expect to find in such a book. The results obtained at Christie Hospital, Manchester, and in many other European centers are compared.

The space and description devoted to the benign conditions is somewhat limited but in keeping with the fact that this is a handbook.

In summation, this book is well written and well organized. The author is to be congratulated on

assembling the basic data of radiation therapy and presenting it in a provocative manner. Beside affording an excellent background for the resident or postgraduate student for whom it is designed, the book will be of value to any radiation therapist for a rapid review of common problems.

RÖNTGENDIAGNOSTIK IM KINDESALTER. By Dr. FRANZ SCHMID, Privat-dozent für Kinderheilkunde an der Universität Heidelberg, and Dr. GERHARD WEBER, Professor für pädiatrische Poliklinik an der Universität München. A volume of 546 pages, with 604 illustrations and 30 tables. Published by J. F. Bergmann, München, 1955. Distributed by Lange and Springer, Berlin. Price DM 147.—

The appearance of a new book on pediatric diagnostic radiology is an important event which demands more than the usual degree of critical scrutiny. Even so, one can find only minor faults in the recent volume by Schmid and Weber. The authors are apparently thoroughly familiar not only with the German but also with the Western literature. The book contains a fairly complete consideration of pediatric pathology. No omission of any important disease entity can be found, though some conditions, such as Ellis-van Creveld syndrome, osteoid osteoma, lead poisoning, hypervitaminosis, fluoridosis, intestinal pneumatosis and neuromuscular dystrophies are treated more briefly than one might wish, and not all diseases are adequately illustrated. Epidermolysis bullosa is completely omitted. On the other hand, the differential diagnostic interpretation of lung shadows on plain chest films is given more prominence than the limitations of the method might warrant. None of the tables for skeletal maturation take sex into account. One might take issue with this, but according to the authors it is a deliberate step taken after "very extensive studies" of their own.

Though the quality of reproduction of radiographs (black on a white background) is excellent, the material accessible to the authors was apparently somewhat limited. For instance, no view of a mandible is shown in the discussion of infantile cortical hyperostosis, though it is the mandibular lesions that are most important in this disease. McCune-Albright's disease and Jaffe-Lichtenstein's disease are considered synonymous and Ebstein's disease is treated as a form of tricuspid stenosis. Conversely a distinction is made between "petroleum pneumonia" (with a good prognosis) and "kerosene pneumonia" (with an unfavorable prognosis). This may, of course, be the result of a linguistic error; the German word petroleum is nowadays actually synonymous with the American term kerosene, though sixty years ago the German petroleum corresponded more to the British term naphtha.

The subject index is carefully prepared and

includes reference to the page on which the bibliography for a given subject can be found.

After having established the excellence of this book, one might ask whether it also represents a contribution to the medical literature by presenting material which is not contained in other books of similar scope. The answer lies in the affirmative. The chapter on congenital heart disease goes far beyond the usual limits of presentation found in works on general radiology. The clarity with which the embryology of the heart is discussed is remarkable. Several useful tables on the incidence of the various heart lesions, with the life expectancy and the catheterization findings, are also worthy of notice. All in all, this is a book of great value to the pediatric radiologist.

In Memoriam

JACK FRIEDMAN, M.D.



A brilliant career came to an untimely end in the death of Dr. Jack Friedman in September 1955, at the age of forty-four years. For some two years he had waged a losing battle against a recurring malignant disease, with great courage and tenacity.

Dr. Friedman was born in Rochester, N. Y., but spent his formative years in Chicago. He was graduated from the University of Illinois in medicine in 1938 and interned at Lutheran Deaconess Hospital in Chicago. He spent the following two years in general practice in Chicago and in 1941 entered the Army. There his interest in radiology developed and expanded following a course in x-ray diagnosis

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at the Walter Reed Hospital. He attained the rank of Lieutenant Colonel when he was radiologist at the 177th General Hospital in France.

After separation from the Army, Dr. Friedman took a full three-year residency in radiology at the University of Minnesota, leading to an M.S. degree in that specialty. In 1948-49 he made an eight-months tour of important radiologic clinics in Europe, spending the major part of his time at the Karolinska Hospital, Stockholm, where he developed a close friendship with Dr. Knut Lindblom.

Following his return from Europe, he spent a short period at Chicago's Swedish Covenant Hospital as associate radiologist before returning to Minneapolis in 1949. After one and a half years as assistant to Dr. K. Wilhelm Stenstrom in radiotherapy and to Dr. Leo G. Rigler in diagnostic radiology at the University of Minnesota, he became the radiologist at Mount Sinai Hospital, which was completed in 1951. There he built up an outstanding department and was active in the promotion of a laboratory in which it is hoped that much fundamental research will be developed. Dr. Friedman was an enthusiastic teacher, holding an appointment as Clinical Assistant Professor of Radiology at the University of Minnesota. He was a member of various medical and radiological societies, including the Radiological Society of North America and Sigma Xi, honorary scientific society.

Dr. Friedman was the author of numerous papers. His later contributions were concerned with radiological study of the small bowel with reference to a new double-contrast technic, the effects of emotion on the small bowel pattern, and the diagnosis of herniated intervertebral disks by discography.

Apart from his work, Dr. Friedman's greatest pleasure was in his family—his wife Dorothy and daughter Elizabeth—and in the companionship of his numerous friends. The Friedman home was an active social center and it was a delight to be entertained by its charming host and hostess. Jack Friedman had a warm personality and great human understanding. It was a privilege to have known him and been influenced by his leadership. That may have been his greatest contribution.

THOMAS BORDEN MERMER, M.D.

BYRON S. PRICE, M.D.

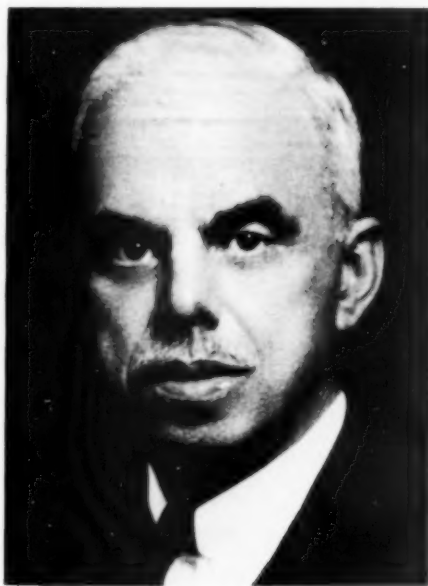
With the death of Byron S. Price, M.D., C.M., of Port Chester, N. Y., the Radiological Society of North America lost one of its few members who began a roentgenologic career using the old static machine. Dr. Price was born in Norton, New Brunswick, Canada, in 1872. He was graduated from McGill University, Montreal, in 1895, and for the next twelve years was in general practice in New Brunswick.

In 1907 Dr. Price entered general practice in New York City, where he used x-rays extensively to aid his diagnoses. He held a position in the clinic of

the Post Graduate Hospital for some years and continued his practice in New York until 1942, when he took up residence in Port Chester. There he continued to work until his death.

THEODORE WEST, M.D.

LAWRENCE A. POMEROY, M.D.



The death of Dr. Lawrence Alson Pomeroy on April 20, 1955, was a great loss to the medical profession, particularly in the field of cancer therapy.

Dr. Pomeroy, son of Dr. Harlan Pomeroy, was born in Cleveland on May 10, 1883, and except for four years at Yale University, spent his life in his native city. He received his degree in medicine in 1908 from Western Reserve University School of Medicine.

Early in his medical career, Dr. Pomeroy became associated with Dr. George W. Crile, under whose influence he developed a keen interest in the treatment of cancer. Though few physicians at that time had much interest in radium therapy, Dr. Pomeroy's prophetic insight led him to investigate the advantages of this new modality and to train himself in intracavitary and interstitial technics for gynecological cancer. In the early twenties, he started a follow-up clinic in the admitting room at Cleveland City Hospital. In 1930, he spearheaded the formation of the first formal tumor clinic in Cleveland at City Hospital, with the approval of the American College of Surgeons.

Dr. Pomeroy was a regional director of the Founders of the American Cancer Society. He was the first president of the Ohio Division for the

American Cancer Society from 1937 to 1943, and in March 1951 he received the Distinguished Service Medal of the Society for his outstanding service to cancer control. He was a consistently active participant in organized medicine and served as president of the Cleveland Academy of Medicine in 1927, president of the American Radium Society in 1939, and chairman of the Board of Trustees of the Cleveland Medical Library Association from 1942 to 1945. In May 1952, he received the Distinguished Service Award of the Cleveland Academy of Medicine for his service to the community and to organized medicine. HARRY HAUSER, M.D.

PHILIP HOWARD COOK, M.D.



The will of Dr. Philip H. Cook, radiologist of Worcester, Mass., who died March 25, 1954, bequeaths the bulk of his estate to Harvard Medical School, his *alma mater*, for "teaching and research in radiology." The will specifies that his estate be used "to establish the Philip H. Cook Fund for Radiology," the income therefrom to be available either for the salary of the incumbent professor or for the support of his work. The approximate current value of the estate is \$425,000.

Dr. Cook was a bachelor, a man of frugal habits and a wise investor. He made Worcester his home for over fifty years and took great interest in civic, charitable, educational, and religious affairs in addition to his professional activities. He was at one time or another secretary and president of the district medical society, an incorporator and later chairman of the Board of Trustees of the Worcester Medical Library, and president of the New England Roentgen Ray Society. He was particularly in-

terested in the Boys Club and the Antiquarian Society. He was a diplomate of the American Board of Radiology and a Fellow of the American College of Radiology.

Dr. Cook was born in Portland, Maine, in 1878. He was graduated from Harvard College in 1899 and from Harvard Medical School, *cum laude*, in 1903. Following an internship at the Worcester City Hospital, during which time he first became interested in x-ray diagnosis, he persuaded Dr. Ernest Hunt to grant him space in the office to set up one of the new-fangled x-ray machines. The following year he was appointed Skiagrapher to the City Hospital, a post he held until his retirement from active practice in 1946.

Dr. Cook's interests outside of his profession were travel and history. Born in a seaport town, he early acquired and always maintained an active interest in maritime affairs and in the ships and men who sailed the seas in the days of the gold rush to California. His own travels took him not only to Europe, but also to South America and the Near East.

For almost ten years after his retirement Dr. Cook spent much of his spare time in the affairs of the Medical Library and the Antiquarian Society. Both organizations received generous bequests in his will. His greatest loyalty and gratitude, however, were to Harvard Medical School, and his keen appreciation of the power and value of a good medical education led to his wise decision. All radiologists and many future patients may be thankful to the pioneer and benefactor, Philip Howard Cook, M.D.

MERRILL C. SOSMAN, M.D.

DAVIS LEE SPRINKLE, M.D.

Dr. Davis Lee Sprinkle of Dallas, Texas, died of a heart ailment on Aug. 27, 1955, at the age of sixty-five. Dr. Sprinkle was born near Temple, Texas, in 1890. He was graduated from the Baylor College of Pharmacology in 1918 and later studied medicine, receiving his M.D. from Baylor University College of Medicine in 1930. After five years of general practice, he turned to radiology, serving his residency at University Hospital, Baltimore. Dr. Sprinkle was successively a radiologist on the staff of the Veterans Administration Hospital, Fort Howard, superintendent and radiologist of the Tampa Memorial Hospital, Tampa, Florida, and radiologist for the Albert Pike and St. Mary's Hospitals, in McAlester, Oklahoma. He practiced radiology in Harlingen, Texas, from 1944 to 1952, when he moved to Dallas, where he was in active practice at the time of his death. He served in the naval medical corps during World War I and was in the naval medical reserve for ten years. Dr. Sprinkle was a member of the Radiological Society of North America and of the Texas Radiological Society.

RADIOLOGICAL SOCIETIES: SECRETARIES AND MEETING DATES

Editor's Note: Secretaries of state and local radiological societies are requested to co-operate in keeping this section up-to-date by notifying the editor promptly of changes in officers and meeting dates.

RADIOLOGICAL SOCIETY OF NORTH AMERICA. *Secretary-Treasurer,* Donald S. Childs, M.D., 713 E. Genesee St., Syracuse 2, N. Y.

AMERICAN RADIUM SOCIETY. *Secretary,* Robert E. Fricke, M. D., Mayo Clinic, Rochester, Minn.

AMERICAN ROENTGEN RAY SOCIETY. *Secretary,* Barton R. Young, M.D., Germantown Hospital, Philadelphia 44, Penna.

AMERICAN COLLEGE OF RADIOLOGY. *Exec. Secretary,* William C. Stronach, 20 N. Wacker Dr., Chicago 6.

ASSOCIATION OF UNIVERSITY RADIOLOGISTS. *Secretary-Treasurer,* Robert J. Bloor, M.D., 260 Crittenden Blvd., Rochester 20, N. Y.

SECTION ON RADIOLOGY, A. M. A. *Secretary,* Paul C. Hodges, M.D., 950 E. 59th St., Chicago 37.

Alabama

ALABAMA RADIOLOGICAL SOCIETY. *Secretary-Treasurer,* J. A. Meadows, Jr., M.D., Medical Arts Bldg., Birmingham 5.

Arizona

ARIZONA RADIOLOGICAL SOCIETY. *Secretary-Treasurer,* James J. Riordan, M.D., 550 W. Thomas Rd., Phoenix. Annual meeting with State Medical Association; interim meeting in December.

Arkansas

ARKANSAS RADIOLOGICAL SOCIETY. *Secretary,* Joe A. Norton, M.D., 843 Donaghey Bldg., Little Rock. Meets every three months and at meeting of State Medical Society.

California

CALIFORNIA MEDICAL ASSOCIATION, SECTION ON RADIOLOGY. *Secretary,* Austin R. Wilson, M.D., 540 N. Central Ave., Glendale 3.

EAST BAY ROENTGEN SOCIETY. *Secretary,* Dan Tucker, M.D., 434 30th St., Oakland 9. Meets monthly, first Thursday, at Peralta Hospital.

LOS ANGELES RADIOLOGICAL SOCIETY. *Secretary,* Richard A. Kredel, M.D., 65 N. Madison Ave., Pasadena 1. Meets monthly, second Wednesday, Los Angeles County Medical Association Bldg.

NORTHERN CALIFORNIA RADIOLOGICAL CLUB. *Secretary,* H. B. Steward, Jr., M.D., 2920 Capitol Ave., Sacramento. Meets last Monday of each month, September to May.

PACIFIC ROENTGEN SOCIETY. *Secretary,* L. Henry Garland, M.D., 450 Sutter St., San Francisco 8. Meets annually at time of California State Medical Association convention.

RADIOLOGICAL SOCIETY OF SOUTHERN CALIFORNIA. *Secretary-Treasurer,* James B. Irwin, M.D., 1831 Fourth Ave., San Diego.

SAN DIEGO RADIOLOGICAL SOCIETY. *Secretary,* C. W.

Bruner, M.D., 2456 Fourth Ave., San Diego 1. Meets first Wednesday of each month.

SAN FRANCISCO RADIOLOGICAL SOCIETY. *Secretary,* Howard L. Steinbach, M.D., University of California Medical Center, San Francisco 22. Meets quarterly, at Grison's Steak House.

SOUTH BAY RADIOLOGICAL SOCIETY. *Secretary,* Thomas N. Foster, M.D., 630 E. Santa Clara St., San Jose. Meets monthly, second Wednesday.

X-RAY STUDY CLUB OF SAN FRANCISCO. *Secretary,* James T. English, M.D., 2000 Van Ness Ave., San Francisco 9. Meets third Thursday at 7:45, Lane Hall, Stanford University Hospital.

Colorado

COLORADO RADIOLOGICAL SOCIETY. *Secretary,* Dorr H. Burns, M.D., 1776 Vine St., Denver. Meets monthly, third Friday, at University of Colorado Medical Center or Denver Athletic Club.

Connecticut

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary-Treasurer,* John Burbank, M.D., Meriden Hospital, Meriden. Meets bi-monthly, second Wednesday.

District of Columbia

RADIOLOGICAL SECTION, DISTRICT OF COLUMBIA MEDICAL SOCIETY. *Secretary,* John A. Long, M.D., 1801 K St., N.W., Washington 6. Meets third Wednesday, January, March, May, and October, at 8:00 P.M., in Medical Society Library.

Florida

FLORIDA RADIOLOGICAL SOCIETY. *Secretary-Treasurer,* Donald H. Gahagen, M.D., 320 Sweet Bldg., Fort Lauderdale. Meets in April and in October.

GREATER MIAMI RADIOLOGICAL SOCIETY. *Secretary-Treasurer,* Andre S. Capi, M.D., 300 N. 20th Ave., Hollywood, Fla. Meets monthly, third Wednesday, 8:00 P.M.

NORTH FLORIDA RADIOLOGICAL SOCIETY. *Secretary-Treasurer,* Marvin Harlan Johnston, M.D., Five Points Medical Center, Jacksonville 4. Meets quarterly, March, June, September, and December.

Georgia

ATLANTA RADIOLOGICAL SOCIETY. *Secretary-Treasurer,* Charles M. Silverstein, M.D., 3254 Peachtree Rd., N. E. Meets second Friday, September to May.

GEORGIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer,* Herbert M. Olmick, M.D., 417 Persons Bldg., Macon, Ga. Meets in November and at the annual meeting of the State Medical Association.

RICHMOND COUNTY RADIOLOGICAL SOCIETY. *Secretary,* Wm. F. Hamilton, Jr., M.D., University Hospital, Augusta. Meets first Thursday of each month.

Hawaii

RADIOLOGICAL SOCIETY OF HAWAII. *Secretary-Treasurer,* George W. Henry, M.D., 1133 Punchbowl, Honolulu. Meets third Monday of each month.

Illinois

CHICAGO ROENTGEN SOCIETY. *Secretary-Treasurer,* R. Burns Lewis, M.D., 670 N. Michigan Ave., Chicago 11. Meets at the Sheraton Hotel, second Thursday of October, November, January, February, March, and April at 8:00 P.M.

ILLINOIS RADIOLOGICAL SOCIETY. *Secretary-Treasurer,* Stephen L. Casper, M.D., Physicians and Surgeons Clinic, Quincy.

ILLINOIS STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary,* George E. Irwin, Jr., M.D., 427 N. Main St., Bloomington.

Indiana

INDIANA ROENTGEN SOCIETY. *Secretary-Treasurer,* Chester A. Stayton, Jr., M.D., 313 Hume-Mansur Bldg., Indianapolis 4. Meets twice a year, first Sunday in May and during fall meeting of State Medical Association.

TRI-STATE RADIOLOGICAL SOCIETY (Southern Indiana, Northwestern Kentucky, Southeastern Illinois). *Secretary-Treasurer,* Eugene L. Hendershot, M.D., 118 S.E. First St., Evansville, Ind. Meets last Wednesday, October, January, March, and May, 8:00 P.M., at the Elks' Club, Evansville, Ind.

Iowa

IOWA RADIOLOGICAL SOCIETY. *Secretary,* James T. McMillan, M.D., 1104 Bankers Trust Bldg., Des Moines. Meets during annual session of State Medical Society, and in the Fall.

Kansas

KANSAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer,* G. S. Ripley, Jr., M.D., W. Iron Ave., Salina. Meets in the Spring with the State Medical Society and in the Winter on call.

Kentucky

KENTUCKY RADIOLOGICAL SOCIETY. *Secretary,* David Shapiro, M.D., Jewish Hospital, 217 E. Chestnut St., Louisville 6. Meets monthly, second Friday, at Seelbach Hotel, Louisville.

Louisiana

ORLEANS PARISH RADIOLOGICAL SOCIETY. *Secretary,* Joseph V. Schlosser, M.D., Charity Hospital of Louisiana, New Orleans 13. Meets second Tuesday of each month.

RADIOLOGICAL SOCIETY OF LOUISIANA. *Secretary-Treasurer,* W. S. Neal, M.D., 602 Pere Marquette Bldg., New Orleans.

SHREVEPORT RADIOLOGICAL CLUB. *Secretary,* W. R. Harwell, M.D., 608 Travis St. Meets monthly September to May, third Wednesday.

Maine

MAINE RADIOLOGICAL SOCIETY. *Secretary-Treasurer,* Walter A. Russell, M.D., Augusta General Hospital, Augusta. Meets in June, October, December, and April.

Maryland

BALTIMORE CITY MEDICAL SOCIETY, RADIOLOGICAL SECTION. *Secretary-Treasurer,* Nathan B. Hyman, M.D., 1805 Eutaw Place, Baltimore 17. Meets third Tuesday, September to May.

MARYLAND RADIOLOGICAL SOCIETY. *Secretary-Treasurer,* Paul W. Roman, M.D., 1810 Eutaw Place, Baltimore 17.

Michigan

DETROIT X-RAY AND RADIUM SOCIETY. *Secretary,* E. F. Lang, M.D., Harper Hospital, Detroit 1. Meets first Thursday, October to May, at Wayne County Medical Society club rooms.

UPPER PENINSULA RADIOLOGICAL SOCIETY. *Secretary,* Arthur Gonty, M.D., Menominee. Meets quarterly.

Minnesota

MINNESOTA RADIOLOGICAL SOCIETY. *Secretary-Treasurer,* O. J. Baggenstoss, M.D., 1953 Medical Arts Bldg., Minneapolis 2. Meets in Spring and Fall and at annual meeting of State Medical Association.

Mississippi

MISSISSIPPI RADIOLOGICAL SOCIETY. *Secretary-Treasurer,* James M. Packer, M.D., 621 High St., Jackson. Meets monthly, on third Tuesday, at 6:30 P.M., at the Hotel Edwards, Jackson.

Missouri

RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY. *Secretary-Treasurer,* D. R. Germann, M.D., University of Kansas Medical Center, Kansas City 3, Kans. Meets last Friday of each month.

ST. LOUIS SOCIETY OF RADIOLOGISTS. *Secretary,* Edwin C. Ernst, Jr., M.D., 3720 Washington Ave., St. Louis 8. Meets on fourth Wednesday, October to May.

Montana

MONTANA RADIOLOGICAL SOCIETY. *Secretary,* John Stewart, M.D., Billings Clinic, Billings. Meets annually.

Nebraska

NEBRASKA RADIOLOGICAL SOCIETY. *Secretary-Treasurer,* James F. Kelly, Jr., M.D., 816 Medical Arts Bldg., Omaha. Meets third Wednesday of each month at 6 P.M. in Omaha or Lincoln.

New England

CONNECTICUT VALLEY RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Thomas J. Crowe, M.D., 53 Center St., Northampton, Mass. Meets second Friday of October and April.

NEW ENGLAND ROENTGEN RAY SOCIETY. *Secretary*, Raymond A. Dillon, M.D., 24 Wedgemere Ave., Winchester, Mass. Meets monthly on third Friday, October through May, at the Hotel Commander, Cambridge, Mass.

New Hampshire

NEW HAMPSHIRE ROENTGEN SOCIETY. *Secretary*, Albert C. Johnson, M.D., 127 Washington St., Keene.

New Jersey

RADIOLOGICAL SOCIETY OF NEW JERSEY. *Secretary*, George G. Green, M.D., 601 Grand Ave., Asbury Park. Meets at Atlantic City at time of State Medical Society and midwinter in Elizabeth.

New York

BROOKLYN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Theodore Kamholtz, M.D., 152 Clinton St. Meets first Thursday, October through May.

BUFFALO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Clayton G. Weig, M.D., 135 Linwood Ave., Buffalo. Meets second Monday, October to May.

CENTRAL NEW YORK ROENTGEN SOCIETY. *Secretary*, Dwight V. Needham, M.D., 608 E. Genesee St., Syracuse 2. Meets in January, May, and October.

KINGS COUNTY RADIOLOGICAL SOCIETY. *Secretary*, Solomon Maranov, M.D., 1450 51st St., Brooklyn 19. Meets fourth Thursday, October to April (except December), at 9:00 P.M., Kings County Medical Bldg.

NASSAU RADIOLOGICAL SOCIETY. *Secretary*, Frances M. Behrendt, 19 Clinton Rd., Garden City, N. Y. Meets second Tuesday, February, April, June, October, and December.

NEW YORK ROENTGEN SOCIETY. *Secretary*, Maxwell H. Poppel, M.D., 550 First Ave., New York 16.

NORTHEASTERN NEW YORK RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Robert R. Wadlund, M.D., Albany Hospital, Albany. Meets in the capital area second Wednesday, October, November, March, and April. Annual meeting in May or June.

RADIOLOGICAL SOCIETY OF NEW YORK STATE. *Secretary-Treasurer*, Mario C. Gian, M.D., 610 Niagara St., Buffalo. Meets annually with the State Medical Society.

ROCHESTER ROENTGEN-RAY SOCIETY. *Secretary-Treasurer*, Charles E. Sherwood, M.D., 260 Crittenden Blvd., Rochester. Meets at Strong Memorial Hospital, 8:15 P.M., last Monday of each month, September through May.

WESTCHESTER RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Maynard G. Priestman, M.D., New Rochelle Hospital, New Rochelle, N. Y. Meets

third Tuesday of January and October and at other times as announced.

North Carolina

RADIOLOGICAL SOCIETY OF NORTH CAROLINA. *Secretary*, William H. Sprunt, M.D., North Carolina Memorial Hospital, Chapel Hill, N. C. Meets in April and October.

North Dakota

NORTH DAKOTA RADIOLOGICAL SOCIETY. *Secretary*, Marianne Wallis, M.D., Minot. Meets in the Spring with State Medical Association; in Fall or Winter on call.

Ohio

OHIO STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John R. Hannan, M.D., 10515 Carnegie Ave., Cleveland 6.

CENTRAL OHIO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Arthur R. Cohen, M.D., 41 S. Grant Ave., Columbus. Meets second Thursday, October, November, January, March, and May, 6:30 P.M., Fort Hayes Hotel, Columbus.

CLEVELAND RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Arthur S. Tucker, M.D., Cleveland Clinic. Meets at 6:45 P.M. on fourth Monday, October to April, inclusive.

GREATER CINCINNATI RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Richard J. Neubauer, M.D., 831 Carew Tower, Cincinnati 2. Meets first Monday, September to June, at Cincinnati General Hospital.

MIAMI VALLEY RADIOLOGICAL SOCIETY. *Secretary*, W. S. Koller, M.D., 60 Wyoming St., Dayton. Meets monthly, second Friday.

Oklahoma

OKLAHOMA STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John R. Danstrom, M.D., Medical Arts Bldg., Oklahoma City.

Oregon

OREGON RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, N. L. Blin, M.D., 210 Jackson Tower, Portland 5. Meets monthly, second Wednesday, October to June, at 8:00 P.M., University Club, Portland.

Pacific Northwest

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Richard Raines, M.D., 214 Medical-Dental Bldg., Portland 5, Ore. Meets annually in May.

Pennsylvania

PENNSYLVANIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Walter P. Bitner, M.D., 234 State St., Harrisburg. Meets annually.

PHILADELPHIA ROENTGEN RAY SOCIETY. *Secretary*, Herbert M. Stauffer, M.D., Temple University Hospital, Philadelphia 40. Meets first Thursday

of each month at 5:00 P.M., from October to May, in Thompson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY. *Secretary-Treasurer*, Norman Tannehill, M.D., 601 Jenkins Bldg., Pittsburgh 22. Meets monthly, second Wednesday, at 6:30 P.M., October to May, at the Hotel Roosevelt.

Rocky Mountain States

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John H. Freed, M.D., 4200 E. Ninth Ave., Denver 7, Colo.

South Carolina

SOUTH CAROLINA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Samuel W. Lippincott, M.D., 103 Rutledge Ave., Charleston. Meets with State Medical Association in May.

South Dakota

RADIOLOGICAL SOCIETY OF SOUTH DAKOTA. *Secretary-Treasurer*, Donald J. Peik, M.D., 303 S. Minnesota Ave., Sioux Falls. Meets during annual meeting of State Medical Society.

The Southwest

SOUTHWESTERN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Gordon L. Black, M.D., 1501 Arizona Bldg., El Paso.

Tennessee

MEMPHIS ROENTGEN SOCIETY. *Secretary*, Benjamin E. Greenberg, M.D., 294 Annella St., Memphis 11. Meets first Monday of each month at John Gaston Hospital.

TENNESSEE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, George K. Henshall, M.D., 311 Medical Arts Bldg., Chattanooga 3. Meets annually with State Medical Society in April.

Texas

DALLAS-FORT WORTH RADIOLOGICAL CLUB. *Secretary*, Albert H. Keene, M.D., 3707 Gaston Ave., Suite 116, Dallas. Meets monthly, third Monday, 6:30 P.M., at the Greater Fort Worth International Airport.

HOUSTON RADIOLOGICAL SOCIETY. *Secretary*, Leslie L. Lemak, 616 Medical Arts Bldg., Houston 2. Meets fourth Monday at the Doctors' Club.

SAN ANTONIO-MILITARY RADIOLOGICAL SOCIETY. *Secretary*, Hugo F. Elmendorf, Jr., M.D., 730 Medical Arts Bldg., San Antonio 5, Texas. Meets at Brook Army Medical Center, the first Monday of each month.

TEXAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. P. O'Bannon, M.D., 650 Fifth Ave., Fort Worth.

Utah

UTAH STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Angus K. Wilson, M.D., 343 S. Main St., Salt Lake City 1. Meets third Wednesday, January, March, May, September, November.

Virginia

VIRGINIA RADIOLOGICAL SOCIETY. *Secretary*, P. B. Parsons, M.D., 1308 Manteo St., Norfolk 7.

Washington

WASHINGTON STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Eva L. Gilbertson, M.D., 1317 Marion St., Seattle 4. Meets fourth Monday, September through May, at 610 Pine St., Seattle.

West Virginia

WEST VIRGINIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, W. Paul Elkin, M.D., 515-519, Medical Arts Bldg., Charleston. Meets concurrently with annual meeting of State Medical Society, and at other times as arranged by Program Committee.

Wisconsin

MILWAUKEE ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, Jerome L. Marks, M.D., 161 W. Wisconsin Ave., Milwaukee 1. Meets monthly on fourth Monday at the University Club.

SECTION ON RADIOLOGY, STATE MEDICAL SOCIETY OF WISCONSIN. *Secretary*, Abraham Melamed, M.D., 425 E. Wisconsin Ave., Milwaukee 2. Meets in October with State Medical Society.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE. Meets first and third Thursday at 4 P.M., September to May, Service Memorial Institute.

WISCONSIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, W. W. Moir, M.D., Sheboygan Memorial Hospital, Sheboygan.

Puerto Rico

ASOCIACIÓN PUERTORRIQUEÑA DE RADIOLOGÍA. *Secretary*, Rafael A. Blanes, M.D., Box 9724 Santurce, Puerto Rico.

CANADA

CANADIAN ASSOCIATION OF RADIOLOGISTS. *Honorary Secretary-Treasurer*, D. L. McRae, M.D., *Assoc. Hon. Secretary-Treasurer*, Guillaume Gill, M.D., *Central Office*, 1555 Summerhill Ave., Montreal 25, Quebec. Meets in January and June.

LA SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTRO-RADIOLOGIE MÉDICALES. *General Secretary*, Ls Ivan Vallée, M.D., Hôpital Saint-Luc, 1058 rue St-Denis, Montreal 18. Meets third Saturday of each month.

L'ASSOCIATION DES RADIOLOGISTES DE LA PROVINCE DE QUEBEC. *ASSOCIATION OF RADIOLOGISTS OF THE PROVINCE OF QUEBEC.* *Secretary*, Isadore Sedlezky, M.D., 3755 Cote St. Catherine Road. Meets four times a year.

CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA. *Secretary*, Dr. Rafael Gómez Zaldívar. Offices in Hospital Mercedes, Havana. Meets monthly.

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGÍA. A. C. *Headquarters*, Calle del Oro, Num. 15, Mexico 7, D. F. *Secretary General*, Dr. Guillermo Santín. Meets first Monday of each month.

PANAMA

SOCIEDAD RADIOLOGICA PANAMEÑA. *Secretary-Editor*, Luis Arrieta Sánchez, M.D., Apartado No. 86, Panama, R. de P.

ABSTRACTS OF CURRENT LITERATURE

ROENTGEN DIAGNOSIS

The Head and Neck

- PAINE, KENNETH W. E., AND McKISOCK, WYLIE. Aqueduct Stenosis. Clinical Aspects, and Results of Treatment by Ventriculocisternostomy (Torkildsen's Operation)..... 125
- ARONSON, NEAL, AND RANSOHOFF, JOSEPH. Chronic Extradural Hematoma of the Posterior Fossa. A Case with a Diagnostic Pneumoencephalographic Finding..... 125
- HOFFMANN, G. R., ET AL. Carotid Angiography in Cerebral Tumors..... 125
- SHAPIRO, ROBERT, AND ROBINSON, FRANKLIN. Roentgenographic Diagnosis of the Arnold-Chiari Malformation..... 125
- CHUSID, EMANUEL, AND BERNSTEIN, ALFRED J. Adventitious Deposition of Iodized Oil in Middle Ear..... 126
- McDONALD, RALPH E., AND SHAFER, WILLIAM G. Disseminated Juvenile Fibrous Dysplasia of the Jaws..... 126
- RAUCH, S. Hereditary Leontiasis Ossea of the Maxilla..... 126

The Chest

- CUNNINGHAM, GEORGE J. Studies in Lung Structure by Low-Voltage Radiography..... 126
- SALVINI, L. Rounded "Double-Contour" Opacities in Pulmonary Disease..... 126
- GOULD, DAVID M., AND TORRANCE, DANIEL J. Pulmonary Edema..... 127
- VAN EPPS, EUGENE F., AND DAVIES, DALE H. Lobar Emphysema..... 127
- ADLER, RICHARD H., ET AL. The Middle Lobe Syndrome and Its Relationship to Certain Aspects of Middle Lobe Disease..... 127
- GUDBJERG, CARL E. Roentgenologic Diagnosis of Bronchiectasis. An Analysis of 112 Cases..... 128
- LOMBARDI, GUIDO. Contribution to the Radiological Study of Congenital Pulmonary Cysts in Children..... 128
- LOMBARDI, GUIDO. The Radiologic Picture of the Pneumocoele in Children..... 128
- RIGLER, LEO G. A New Roentgen Sign of Malignancy in the Solitary Pulmonary Nodule... 129
- GUISS, LEWIS W. Mass Roentgenographic Screening as a Lung-Cancer-Control Measure..... 129
- OVERHOLT, RICHARD H., ET AL. Surgical Treatment of Lung Cancer Found on X-Ray Survey..... 129
- SCHMIDT, CHARLES E. Comparison of Roentgenographic and Surgical Findings in Tuberculosis..... 129
- FEIG, MILTON, AND JENSEN, AGNES. The Wisconsin State Board of Health Mobile Unit X-Ray Surveys (1949-1951); A Report of 494,442 70 mm. X-Rays, 19,579 Referrals... 129

- COMSTOCK, GEORGE W., AND SARTWELL, PHILIP E. Tuberculosis Studies in Muscogee County, Georgia. IV. Evaluation of a Community-Wide X-Ray Survey on the Basis of Six Years of Observations..... 130
- GUILD, WARREN R. Photofluorography at a U. S. Naval Shipyard..... 130
- BRISTOL, LEONARD J. Roentgenologic Aspects of Silicosis and Asbestosis..... 130
- SALINE, MYRON, AND BAUM, GEORGE L. The Submersion Syndrome..... 131
- BERNARD, ETIENNE, AND WOLFF, CH. Labile and Migratory Pulmonary Infiltrate with Eosinophilia..... 131
- FALLIERS, CONSTANTINE J. Cervical Hernia of the Lungs..... 131
- DONEGAN, CHARLES K., AND NOUSE, DON C. Diagnostic Difficulties in Evaluating Pulsating Mediastinal Masses..... 131
- ABALLI, ARTURO J., ET AL. Mediastinal Emphysema in the Newborn..... 131
- DEL BUONO, PIETRO, AND MARTINO, LUIGI. Hilar Lymph Nodes in Chronic Pulmonary Stasis..... 132

The Cardiovascular System

- WITTENBORG, MARTIN H., AND NEUHAUSER, EDWARD B. D. Diagnostic Roentgenology in Congenital Heart Disease..... 132
- RODRÍGUEZ-ALVAREZ, ANTONIO, AND DORBECKER, NARNO. Studies in Angiocardiography: The Problem of Injection. Presentation of a High-Pressure Automatic Injecting Machine to Meet the Needs of Modern Angiocardiography..... 133
- SUSSMAN, MARCY L., AND JACOBSON, GEORGE. A Critical Evaluation of the Roentgen Criteria of Right Ventricular Enlargement..... 133
- PASTOR, BERNARD H., ET AL. The Demonstration of Left Atrial Enlargement by Body Section Radiography..... 134
- SAYMAN, ISMET. The Diagnosis of Bundle Branch Block by the Kymographic Method..... 134
- DACK, SIMON. The Ventricular Pulsations in Myocardial Infarction; a Fluoroscopic and Kymographic Study..... 134
- CHENG, TSUNG O., AND SUTTON, DON C. Primary Hemangioendotheliosarcoma of the Heart Diagnosed by Angiocardiography. Review of the Literature and Report of a Case..... 134
- ESPOSITO, MICHAEL J. Focal Pulmonary Hemosiderosis in Rheumatic Heart Disease..... 134
- FOWLER, NOBLE O., ET AL. The Clinical Estimation of Pulmonary Hypertension Accompanying Mitral Stenosis..... 135

- SOLOFF, LOUIS A., ET AL. Use of Planigraphy in Demonstration of Calcification of Heart Valves and Its Significance. 135
- BILLINGS, F. T., JR., AND COUCH, O. A., JR. Pericardial Calcification and Histoplasmin Sensitivity. 136
- DE CARVALHO AZEVEDO, A., ET AL. Congenital Lutembacher Syndrome. 136
- MILLER, GEORGE, ET AL. Persistent Left Superior Vena Cava. 136
- ANDERSON, RAY C., ET AL. Anomalous Inferior Vena Cava with Azygous Drainage: So-called Absence of the Inferior Vena Cava. 136
- LANDRY, SAUL F., JR., AND SALATICH, JOHN S. Anomalous Pulmonary Arteries. 137
- CORNET, ET AL. Traumatic Aneurysm of the Right Lower Pulmonary Lobe: Sequel of a Shell Wound. Lobectomy. Cure. 137
- TORI, G., AND CAVICCHI, L. Transosseous Mediastinal Phlebography. 137
- FIGLEV, MELVIN M., ET AL. Percutaneous Splenoportography. 137
- GVOZDANOVIC, V., AND HAUPTMANN, E. Further Experience with Percutaneous Lieno-Portal Venography. 137
- LYNN, R. B., ET AL. Arteriographic Appearances of the Digital Arteries of the Hands in Raynaud's Disease. 138
- The Digestive System**
- PIACENTINI, LUIGI. Leiomyoma of the Esophagus. 138
- PRICE, E. ALAN. Gastric Diverticula. 138
- OLER, WESLEY M., AND CRAEMER, VIRGINIA C. Effects of Two Commercial Emulsifiers, MYRJ 45 and MYRJ 52, on Gastric Acidity and Gastrointestinal Motility of Human Subjects. 139
- GOLODNER, HARRY, ET AL. Papillary Lymph Nodule Hyperplasia of the Duodenum (Report of a Case). 139
- GROSSI, VINCI. Radiologic Features of Perforations of Duodenal Ulcers into Extrahepatic Biliary Ducts. 139
- KLEITSCH, W. P., ET AL. Carcinoma of Jejunum in Intestinal Polyposis with Oral and Digital Melanosis. 139
- ANDRÉN, LARS, ET AL. Roentgen Diagnosis of Small Polyps in the Colon and Rectum. 140
- HULTBORN, K. A., ET AL. The So-called Shelf Tumour of the Rectum. 140
- KANTOR, HERBERT G., ET AL. Cholangiography: A Critical Analysis. 140
- BERK, J. EDWARD, ET AL. The Normal and Abnormal Biliary Tract as Shown by Intravenous Cholecystography and Cholangiography. 141
- HUDAK, A. Oral Cholangiography and the Pancreas in Radiology. 141
- Retroperitoneal Tumors**
- BERRY, JOHN F., ET AL. Abdominal Aortography. 141
- FULTON, HAROLD, AND EVANS, W. A., JR. Roentgen Examination in Retroperitoneal Tumors of Children. 141
- STEINBACH, HOWARD L., AND SMITH, DONALD R. Extraperitoneal Pneumography in Diagnosis of Retroperitoneal Tumors. 142
- EVANS, ARTHUR T. Combined Use of Contrast Media in Retroperitoneal Tumors. 142
- Hernia**
- STUCKI-VON MURALT, PETER. The Roentgen Appearance of Abdominal Hernias. 143
- HALL, GEORGE V., AND NEWTON, NOEL C. A Review of 70 Cases of Hiatal Hernia, with Particular Reference to Symptomatology. 143
- The Musculoskeletal System**
- WEISS, HOWARD, AND CROSETT, ALEXANDER D., JR. Chondroectodermal Dysplasia. Report of a Case and Review of the Literature. 144
- MARCELINO FIGUEROA C., J., AND SILVA AGUILAR, MARIO. Osteomyelitis in the Newborn and Infant up to Two Months of Age. 144
- ANGEI, ALDO, AND COSSU, RAIMONDO. Bone Infarct. Clinico-Radiologic Contribution. 144
- PERKINSON, NEIL G., AND HIGINBOTHAM, NORMAN L. Osteogenic Sarcoma Arising in Polyostotic Fibrous Dysplasia. Report of a Case. 145
- REINHARDT, K., AND PANTER, K. Myelographic Procedures. Results and Risks. 145
- STINCHFIELD, FRANK E., AND SINTON, WILLIAM A. Clinical Significance of the Transitional Lumbosacral Vertebra. Relationship to Back Pain, Disk Disease, and Sciatica. 145
- RAVELLI, A. Osteochondritis Dissecans in the Navicular Bone of the Wrist. 145
- The Spinal Cord**
- CUNEO, HENRY M. Spinal Extradural Cysts. Report of a Case. 146
- Gynecology and Obstetrics**
- ZUMMO, BRUCE P., ET AL. Diagnosis and Prognosis of Female Genital Tuberculosis. 146
- WATSON, H. G. X-Ray Visualization of the Placenta. 146
- WILLIAMS, JOHN L. Gas in the Symphysis Pubis During and Following Pregnancy. 146
- FERNSTRÖM, INGMAR. Arteriography of the Uterine Artery: Its Value in the Diagnosis of Uterine Fibromyoma, Tubal Pregnancy, Adnexal Tumour, and Placental Site Localization in Cases of Intra-Uterine Pregnancy. 146
- The Genitourinary System**
- RICHES, E. W. The Present Status of Renal Angiography. 147
- TICE, G. M. Experience with a New Urographic Agent—Hypaque. 147
- JACOBS, LEWIS G. Total Tuberculous Calcification of a Kidney and Ureter. 148

- COONEY, JOHN D., ET AL. Renal Displacement and Rotation During Retroperitoneal Pneumography..... 148

The Adrenals

- SNYDER, C. H., AND RUTLEDGE, L. J. Pheochromocytoma—Localization by Aortography..... 148

Miscellaneous

- GERSHON-COHEN, J., ET AL. Occult Carcinoma of Breast. Value of Roentgenography..... 148
LEIGH, TED F., AND ROGERS, JAMES V., JR. Retroperitoneal Liposarcomas..... 148
THOMPSON, THOMAS M. X-Ray Visualization of Surgical Sponges..... 148
KAY, SAUL, AND CHOV, SUN HAK. Results of Intraperitoneal Injection of Barium Sulfate Contrast Medium..... 149

Technic

- MATTSSON, OVE. Practical Photographic Problems in Radiography with Special Reference to High-Voltage Technique..... 149
VERBIEST, H., ET AL. Cineradiography of the Cerebral Angiogram with the Philips Image Amplifier Tube..... 150
MENESES HOYOS, JORGE. "Geometric" Method to Calculate the Aortic Caliber from Anteroposterior Teleroentgenograms..... 150
NOBLE, FRANK W., ET AL. A Cardio-Roentgen Actuator: An Instrument for Actuating the Roentgenoscope in End Systole or End Diastole of the Heart Action..... 151

RADIOTHERAPY

- ARNOLD, ARTHUR, ET AL. The Application of the Betatron to the Treatment of Brain Tumors..... 151
HORRAX, GILBERT, ET AL. Present-Day Treatment of Pituitary Adenomas..... 151
SKRIMSHIRE, J. F. P. Radiotherapy of Cushing's Syndrome..... 151
BUCKWALTER, JOSEPH A., AND MEREDITH, L. K. Small Cell Carcinoma of the Thyroid Gland of Youth..... 152
HEYMAN, JAMES. Some Problems of Current Interest Relating to Classification and Treatment of Uterine Carcinoma..... 152
DARGENT, M., AND GUILLEMIN, G. The Treatment of Operable Cancer of the Cervix by the Combination of Radiation and Surgery..... 152
VAN HERIK, MARTIN, AND FRICKE, ROBERT E. The Results of Radiation Therapy for Recurrent Cancer of the Cervix Uteri..... 152
BOLOGNESI, MINO, AND BISTOLFI, FRANCO. Initial Clinical Results of Roentgen Therapy with Grid in Advanced Cancer of Uterus..... 153
SILVERSTONE, SIDNEY M. A New Improved Type of Colpostat..... 153
GRAHAM, RUTH M., AND GRAHAM, JOHN B. Cytological Prognosis in Cancer of the Uterine Cervix Treated Radiologically..... 153

- GRAHAM, RUTH M., AND GOLDIE, KATHERINE R. Prognosis in Irradiated Cancer of the Cervix by Measurement of Cell Size in the Vaginal Smear..... 154
SADLER, JOHN M. Problems Associated with Cancer of the Endometrium..... 154
LOEFFLER, R. KENNETH. A System of Radium Distribution for Treatment of Cancer of the Corpus Uteri..... 154
BEECHAM, CLAYTON T., ET AL. Nitrogen Mustard and X-Ray in the Treatment of Pulmonary Metastases from Choriocarcinoma..... 154
LONGO, GIUSEPPE. Osteo-Epiphyseal Roentgen Therapy in Lipoid Nephrosis..... 155

RADIOISOTOPES

- AMYES, EDWIN W., ET AL. Determining the Site of Brain Tumors. The Use of Radioactive Iodine and Phosphorus..... 155
LEVI, J. ELLIOT, AND SILBERSTEIN, HANNAH E. Lack of Effect of Fluorine Ingestion on Uptake of Iodine¹³¹ by the Thyroid Gland..... 155
OLMSTED, LEVONA W., AND BEIERWALTES, WILLIAM H. Thyroidectomizing Dose of Radioactive Iodine in Humans with Malignant Melanoma..... 156
MOSES, CAMPBELL, ET AL. Experimental and Clinical Studies with Radioactive Colloidal Gold in the Therapy of Serous Effusions Arising from Cancer..... 156
NELSON, CHARLES M. Use of Radioactive Gold in the Treatment of Carcinoma of the Bladder. Report of 8 Cases..... 156
MORRIS, NORMAN, ET AL. Effective Circulation of the Uterine Wall in Late Pregnancy Measured with Na²⁴Cl..... 156
BLAND, WILLIAM H., ET AL. Radioisotope Studies in Neuromuscular Disease. 2. Studies in Muscular Dystrophy and Myotonia Dystrophica with Sodium²² and Potassium⁴²..... 157
VEALL, N., ET AL. An Improved Method for Clinical Studies of Total Exchangeable Sodium Using ²²Na and a Whole-Body Counting Technique..... 157
MAGNUSSON, GÖSTA, ET AL. Studies on the Uptake of Fe⁵⁹ in Rat Embryo, Placenta, Uterus and Mammary Gland..... 157
ODELL, T. T., JR., ET AL. Uptake of Radioactive Sulfate by Elements of the Blood and the Bone Marrow of Rats..... 157
BURCH, G. E., ET AL. The Rate of Disappearance of Rb⁸⁶ from the Plasma, the Biologic Decay Rates of Rb⁸⁶, and the Applicability of Rb⁸⁶ as a Tracer of Potassium in Man With and Without Chronic Congestive Heart Failure..... 157
THREEFOOT, S. A., ET AL. Study of the Use of Rb⁸⁶ as a Tracer for the Measurement of Rb⁸⁶ and K³⁹ Space and Mass in Intact Man With and Without Congestive Heart Failure..... 158

- RAY, C. T., ET AL. The Excretion of Radiorubidium, Rb^{86} , Radiopotassium, K^{42} , and Potassium, Sodium, and Chloride, by Man With and Without Congestive Heart Failure 158
- ODEBLAD, ERIK, AND NATI, GIUSEPPE. Detection of Beryllium by Means of the Be^9 (α, γ) C^{12} Reaction. 158
- ODEBLAD, ERIK, ET AL. Autoradiographic Study of the Distribution of Radioactive Particulate Chromic Phosphate in Liver, Spleen, and Lung of the Mouse. 158

RADIATION EFFECTS

- MACHT, STANLEY H., AND LAWRENCE, PHILIP S. National Survey of Congenital Malformations Resulting from Exposure to Roentgen Radiation. 159
- CROW, JAMES F. A Comparison of Fetal and Infant Death Rates in the Progeny of Radiologists and Pathologists. 159
- MCDONALD, JAMES E., ET AL. Beta Radiation Cataracts. 159
- KATZ, ELAINE J., AND HASTERLIK, ROBERT J. Aminoaciduria Following Total-Body Irradiation in the Human. 160
- ALBERT, ROY, ET AL. Industrial Hygiene and Medical Survey of a Thorium Refinery. 160
- LORENZ, EGON, ET AL. Long-Term Effects of Acute and Chronic Irradiation in Mice. I. Survival and Tumor Incidence Following Chronic Irradiation of 0.11 r Per Day. 161
- CONGDON, CHARLES C., ET AL. The Histopathology of Bacterial Infection in Irradiated Mice. 161
- HOLLCROFT, JOANNE WEIKEL, ET AL. Long-term Survival Following X Irradiation and the Irradiation of the α -Particles from Radon and Its Decay Products. 161
- BARNES, DAVID W. H., AND LOUIT, JOHN F. The Radiation Recovery Factor: Preservation by the Poige-Smith-Parkes Technique. 161
- MOLE, R. H. On Wasted Radiation and the Interpretation of Experiments with Chronic Irradiation. 161
- DERINGER, MARGARET K., AND LORENZ, EGON. Results of Exposure of Newborn Strain HR Mice to X Radiation. 162
- WEYMOUTH, PATRICIA P., ET AL. Nucleic Acid Content of the Thymic Cells of Normal and Irradiated C57BL Mice. 162
- MERWIN, RUTH M., AND HILL, ELIZABETH L. Effect of Local Roentgen Irradiation on the Formation of New Capillaries after Injury. 162
- KOHN, HENRY I., AND KALLMAN, ROBERT F. The Effect of Fractionated X-Ray Dosage Upon the Mouse Testis. I. Maximum Weight Loss Following 80 to 240 r Given in 2 to 5 Fractions During 1 to 4 Days. 162
- DERINGER, MARGARET K., ET AL. Fertility and Tumor Development in (C57L X A) F_1 Hybrid Mice Receiving X Radiation to Ovaries Only, to Whole Body, and to Whole Body with Ovaries Shielded. 163
- UPTON, ARTHUR C., AND FURTH, JACOB. Spontaneous and Radiation-Induced Pituitary Adenomas of Mice. 163
- MAIN, JOHN M., AND PREHN, RICHMOND T. Successful Skin Homografts After the Administration of High Dosage X Radiation and Homologous Bone Marrow. 163
- KOLETSKY, SIMON, AND GUASTAFSON, GORDON E. Whole-Body Radiation as a Carcinogenic Agent. 164
- WHITE, JULIUS, ET AL. Cirrhosis of the Liver in Rats Following Total-Body X Irradiation. 164
- WHITE, JULIUS, ET AL. Level of Protein Intake and Nitrogen Excretion in Rats Following Total-Body X Irradiation. 164
- SHECHMEISTER, I. L., AND FISHMAN, M. The Effect of Ionizing Radiation on Phagocytosis and the Bactericidal Power of the Blood. I. Effect on Migration of Leucocytes. 164
- FISHMAN, M., AND SHECHMEISTER, I. L. The Effect of Ionizing Radiation on Phagocytosis and the Bactericidal Power of the Blood. II. The Effect of Radiation on Ingestion and Digestion of Bacteria. 164
- SAVITSKY, J. PHILIP. Leucocyte Adhesiveness Following Whole Body Irradiation. 165
- PRATT, A. W., ET AL. Recovery at Low Temperature of X-Irradiated *E. coli* Cells. 165
- BACHOFER, C. S., AND PAHL, GEORGE. Influence of Extended Temperature Treatments on Recovery of X-Irradiated *Ascaris* Eggs. 165
- ARNASON, T. J., AND MORRISON, MARGARET. A Comparison of the Effectiveness of Radiations of Different Energies in Producing Chromosome Breaks. 165
- GILES, NORMAN H. The Oxygen Effect on Radiation-Induced Chromosome Aberrations: Breakage-Versus-Recombination Hypothesis 166
- GREEN, JAMES W., AND ROTH, JAY S. The Effect of Radiation from Small Amounts of P^{32} , S^{35} and K^{42} on the Development of *Arbacia* Eggs 166
- CLOUDMAN, ARTHUR M., ET AL. Effects of Combined Local Treatment with Radioactive and Chemical Carcinogens. 166
- LACASSAGNE, A., ET AL. New Experiments on Protection Against Whole-Body Irradiation. 167
- BROWN, MARY B., ET AL. Some Biological Aspects of the Factor in Bone Marrow Responsible for Hematopoietic Recovery Following Systemic Irradiation. 167
- KAPLAN, HENRY S., ET AL. The Time Factor in Inhibition of Lymphoid-Tumor Development by Injection of Marrow Cell Suspensions into Irradiated C57BL Mice. 167
- STROUD, AGNES N., ET AL. Protection of Mice Against X Irradiation by Plasma Proteins. 168
- BURGER, HANS, AND PETERS, KARL. Irradiation Protection through Removal of Cell Toxins with Kollidon (Polyvinylpyrrolidon). 168

ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Aqueduct Stenosis. Clinical Aspects, and Results of Treatment by Ventriculocisternostomy (Torkildsen's Operation). Kenneth W. E. Paine and Wylie McKissock. *J. Neurosurg.* 12: 127-145, March 1955.

The authors report the results of treatment of 25 patients with stenosis of the aqueduct of Sylvius at the National Hospital in London. Ventriculocisternostomy was performed on these patients at ages ranging from eighteen weeks to fifty-eight years. The one infant operated upon in the first year of life was among those who died in the immediate postoperative period, which would support Matson's conclusion (*J. Neurosurg.* 8: 398, 1951) that extreme youth is a contraindication to the performance of the operation. In about two-thirds of the patients, symptoms developed before the age of twenty years, but differentiation of congenital from acquired cases on this basis was impossible. There was a wide variation in the duration of symptoms (three weeks to forty-six years).

Headache was a symptom in 22 patients, but in only 12 could it be said to be the presenting complaint. Nausea and vomiting were present in 13, visual failure in 12, mental defect or deterioration in 11, unsteadiness in 10. The physical examination uncovered optical evidence of increased intracranial pressure in 21 patients, ataxia in 14, pyramidal signs in 11, obesity in 12.

Plain roentgenograms of the skull demonstrated raised intracranial pressure in 20 instances. In 4 patients the posterior fossa was small. A frequent finding on plain films was the presence of large diploic channels in the occipital bone. Ventriculography was performed in 24 cases, with air only in 12, Myodil (Pantopaque) only in 5, and both air and Myodil in 7. On the basis of the appearance of the stenosed portion of the aqueduct the authors have divided their cases into 4 groups: (1) partial occlusion; (2) funneled aqueduct; (3) bulbous type; (4) atresia of the aqueduct.

The technic of operation is described. Soft rubber catheters were used to form a ventricular by-pass. Six patients died, 5 of them in the immediate postoperative period and 1 seven months after surgery from what seemed to have been the effects of a continued rise of intracranial pressure (*i.e.*, failure of the operation). One patient's condition continued to deteriorate after surgery. In 2 cases hemiplegia resulted, although hydrocephalus was arrested by the operation. Thus, there were considered to be 9 operative failures. Nine patients, on the other hand, did well and were able to assume full-time occupation in school or work, although 1 was blind. Three other patients had their symptoms arrested, but did not gain enough vision or ability to work to attain an economic adjustment. The remaining 4 patients were improving but the follow-up was too short for definitive evaluation.

The authors warn that even when hydrocephalus is arrested by a short-circuit operation, visual deterioration is unlikely to be reversed and, indeed, may further increase with the appearance of secondary optic atrophy. They believe that the earlier the diagnosis can be made and the treatment undertaken, the better will be the late results of surgery.

Nine roentgenograms; 3 tables.
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Chronic Extradural Hematoma of the Posterior Fossa. A Case with a Diagnostic Pneumoencephalographic Finding. Neal Aronson and Joseph Ransohoff. *Neurology* 5: 215-217, March 1955.

A case of chronic extradural hematoma of the posterior fossa is presented. This is the second chronic case to be recorded in the literature (for the earlier case, see Turnbull: *J. Neurosurg.* 1: 321, 1944). A previously unmentioned and probably diagnostic pneumoencephalographic finding was observed, consisting of a comma-shaped posterior indentation of the cisterna magna. This comma-shaped filling defect is characteristic of hematomas in general, as Dyke (*Bull. Neurol. Inst.* 5: 135, 1936) pointed out with regard to subdural hematomas of the supratentorial space. Such a defect could, of course, be produced by either an extradural or subdural hematoma, since the indentation is due to an extra-arachnoidal mass, regardless of whether it is intradural or extradural.

One roentgenogram.

Carotid Angiography in Cerebral Tumors. G. R. Hoffmann, P. Chabeau, and S. F. Lemahieu. *J. belge de radiol.* 38: 113-166, 1955. (In French)

The history of the development of carotid angiography and the normal vasculature of the head are reviewed. Carotid angiography has proved of great value in the diagnosis and localization of tumors on the anterior and median supratentorial levels, demonstrating the vascular pattern of the lesion and displacement of the larger vessels. In 1,400 examinations no serious complications have been encountered. The tumors are illustrated by 55 roentgenograms and sketches.

CHARLES M. NICE, JR., M.D.
University of Minnesota

Roentgenographic Diagnosis of the Arnold-Chiari Malformation. Robert Shapiro and Franklin Robinson. *Am. J. Roentgenol.* 73: 390-395, March 1955.

The pertinent pathological findings of the complete Arnold-Chiari deformity are: (1) downward prolongation of the inferior portion of the cerebellar hemispheres for a variable distance within the cervical spinal canal (Arnold component); (2) caudal displacement of the medulla and spinal cord. The medulla is displaced inferiorly and dorsally upon the upper cervical cord, producing a posterior bulge at the medullocervical junction (Chiari component). The two components usually coexist, although either may occur alone or may predominate.

The authors summarize the roentgen findings as follows: In the pure uncomplicated Arnold-type malformation, myelography demonstrates an obstructive cervical lesion with an inferior bifid lobulated border produced by the inferior margin of the herniated cerebellar hemispheres, the central incisura corresponding to the space between the cerebellar hemispheres. This contour may, however, be produced by any lobulated intradural extramedullary tumor. Similarly, in the presence of dense adhesions over the cerebellum, the central incisura may be obliterated and hence the myelographic pattern will resemble that commonly seen with intradural extramedullary lesions, *e.g.*, neurofibroma or meningioma.

The combined Arnold-Chiari deformity or the Chiari component *per se* results in buckling and down-

ward displacement of the medulla against the cervical cord. Consequently, if only the inferior portion of the lesion is visualized, the typical bilobate pattern may not be seen. Instead, one may find a block with a deformity of the myelographic column suggestive of an intradural tumor. However, if sufficient Pantopaque passes up to delineate the superior border of the lesion and the latter is poorly defined, the diagnosis of tumor is less likely. Similarly, distortion of the normal contour of the cisterna magna favors the diagnosis of the Arnold-Chiari malformation.

A case of Arnold-Chiari malformation and 2 cases of high spinal meningioma are reported.

Three roentgenograms.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Adventitious Deposition of Iodized Oil in Middle Ear. Emanuel Chusid and Alfred J. Bernstein. *Am. J. Dis. Child.* 89: 359-360, March 1955.

Deposits of iodized oil (Lipiodol) were demonstrated in the middle ear and mastoid area of a newborn infant following a gastrointestinal examination with iodized oil. The oil is believed to have reached the middle ear via the Eustachian tube.

Four roentgenograms.

PAUL MASSIK, M.D.
Quincy, Mass.

Disseminated Juvenile Fibrous Dysplasia of the Jaws. Ralph E. McDonald and William G. Shafer. *Am. J. Dis. Child.* 89: 354-358, March 1955.

The authors present a case of so-called "cherubism" in a five-year-old girl with bilateral swelling of the jaws, progressive loss of teeth, and speech difficulty. The familial tendency reported by others was not observed in this instance. On physical examination the jaws were found to be swollen by a hemorrhagic ulcerated painless mass. Roentgenograms demonstrated large cystic areas resembling giant-cell tumors. A number of permanent tooth buds were absent. This, however, appears to be a developmental lack rather than a result of the disease process. A skeletal survey revealed no other bony lesions. A bone biopsy was interpreted as fibrous dysplasia.

Observation over a ten-month period showed no change. No treatment was instituted, although surgery may be indicated for cosmetic reasons at a later date.

Fourteen roentgenograms; 2 photomicrographs; 2 photographs.

PAUL MASSIK, M.D.
Quincy, Mass.

Hereditary Leontiasis Ossea of the Maxilla. S. Rauch. *Radiol. clin.* 24: 100-105, March 1955. (In German)

Some 90 per cent of cases of leontiasis ossea are the result of Paget's disease. While isolated Paget's disease of the maxilla has been described before, the hereditary form is not widely known.

The author's patient, a man of sixty-eight with a history of Paget's disease of the maxilla for ten to fifteen years, was seen because of an antral osteomyelitis following a tooth extraction. Biopsy at the time of surgery revealed a typical picture of Paget's disease complicated by infection. Roentgenologic study showed the disease to be confined to the maxilla. The antra were almost completely obliterated. Clinical features

were a slight prognathism and an enlarged superior alveolar process.

The patient's mother and maternal aunts had similar changes, also limited to the maxilla.

Two roentgenograms; 2 photomicrographs; 2 photographs.

CHRISTIAN V. CIMMINO, M.D.
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THE CHEST

Studies in Lung Structure by Low-Voltage Radiography. George J. Cunningham. *Am. J. Clin. Path.* 25: 253-260, March 1955.

A technic of low-voltage (20 or 30 kv) radiography of soft tissue is described, with particular reference to the study of lung structure in autopsy or surgical specimens. For lesions such as emphysema, where the lung tissue is fine and atrophic, slices of 0.5 cm. or even more can be satisfactorily radiographed. For normal lung or for fibrotic lesions, the slice must be thinner; 0.2 or 0.3 cm. is preferable. A few hours before radiography, the slices to be examined are transferred from the fixative to 70 per cent alcohol. The final preparation of the specimen consists of blotting it gently several times in order to remove as much as possible of the alcohol, as the radiographic details are clearest when air rather than liquid is present in the respiratory tissue.

The x-ray tube employed is similar to that used in crystallographic studies. The specimen is held firmly in a plastic frame between two sheets of cellulose acetate sheeting 0.003 in. thick. Photographic film is used for recording. Films of half-plate size are held in light-tight envelopes made from the black paper wrappings of x-ray films. If fine detail radiographs are desired, the specimen should be as close as possible to the film, and in this case only one layer of black paper and one layer of cellulose acetate sheeting separate the two. In order to obtain an x-ray beam that would cover the half-plate film, the specimen is placed 36 inches from the focal spot of the tube. At this distance the exposure is necessarily long, usually about four or five minutes.

Whereas pictures obtained by historadiography closely resemble photomicrographs, those obtained by the method described are more like what is seen with the naked eye, with the additional advantage that a depth of tissue is actually being viewed. This latter feature is turned to advantage by taking stereoscopic radiographs which, when enlarged and viewed in a Wheatstone stereoscope adapted for the purpose, give a picture similar to that seen with a dissecting microscope but with a better appreciation of depth.

The procedure is chiefly applicable to a study of lung pathology and is particularly suitable in conditions in which the elasticity of the lung tissue has been lost. In emphysema one obtains a much better appreciation of just how much reduction of effective lung parenchyma has occurred. Good radiographic detail is seen in those conditions in which the connective tissue is increased, as in pneumoconiosis. The method is also of value in defining the limits of many lesions.

Eight roentgenograms; 1 photomicrograph.

Rounded "Double-Contour" Opacities in Pulmonary Disease. L. Salvini. *Ann. radiol. diag.* 28: 152-172, 1955. (In Italian)

The appearance on a chest roentgenogram of a rounded, well circumscribed, homogeneous increase in

density with "double contour" (*i.e.*, with a crescent-shaped or circular layer of air in the "wall" of the opacity) has been described as pathognomonic for echinococcus cyst, but it has also been encountered in necrotic granulomas of mycotic origin, in dermoid cysts, and in atypical tuberculomas or neoplasms. Occasionally even tuberculous cavities may be surrounded by a pyogenic membrane. Actually, the "double contour" is indicative of necrosis and sequestration of lung tissue; an analogy may be made with bone sequestra, which appear more opaque than neighboring osseous structures.

Five cases are reported: 2 of tuberculous cavities, 1 of neoplasm, and 2 in which the appearance remained unchanged for three and five years, respectively, so that a definite diagnosis was impossible.

An attempt is made to establish roentgenologic criteria for etiologic differentiation. The hydatid cyst has a more homogeneous opacity, and its size and shape may be modified by changes in position. By contrast, positional changes cannot alter the solid mass of a dermoid cyst (a tooth might suggest the diagnosis). In tuberculous processes, the involved lung portions reveal increased vascularization. Furthermore, the tuberculous membrane around a cavity is ragged, as opposed to the neat, "pencil-drawn" contour of the mycotic granuloma. In the author's opinion, the "double contour" appearance, when caused by tuberculosis or a fungus, suggests a favorable development (inapposition), *i.e.*, a tendency toward clinical, if not anatomical, healing.

Twenty-one roentgenograms.

E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

Pulmonary Edema. David M. Gould and Daniel J. Torrance. *Am. J. Roentgenol.* 73: 366-374, March 1955.

Any mechanism permitting an increase in the accumulation of fluid in the alveoli will cause pulmonary edema. The following are most important: (1) left ventricular failure; (2) anoxia causing capillary damage; (3) the presence of some toxic substance causing capillary damage; (4) central nervous system stimuli operating through pathways not yet understood.

The authors studied 100 cases of pulmonary edema of various etiology and classified them roentgenographically and morphologically into three working groups: (1) *central edema*, where there is a large, confluent, butterfly-like, roughly symmetrical opacification of both central lung fields; (2) *diffuse edema*, with patchy, ill-defined, diffusely distributed opacifications, roughly symmetrical but scattered throughout both lungs; (3) *focal edema*, including cases with a dense homogeneous opacification bounded by a major fissure and those with one or more isolated large, rounded, discrete shadows resembling a primary or metastatic tumor.

Roentgenologically, pulmonary edema manifests itself by clouding or opacification of the lungs due to the accumulated fluid in the alveoli. The roentgen pattern must be differentiated from congestive changes and also from dilatation of the pulmonary arteries and veins. If the vessels are simply enlarged, they are sharp and clear. In congestive changes due to left ventricular failure, the vessels are both enlarged and hazy in outline. There is no sharp line of demarcation between severe congestive changes and minimal pul-

monary edema. In frank edema the opacification or consolidation completely obliterates the vessels traversing the edematous portion of the lung, since no contrast exists between the fluid-filled vessel and the fluid-filled alveoli. Because the alveoli are filled with fluid, the bronchi which traverse this portion of the edematous lung are revealed as radiolucent linear arborizations.

One hundred cases of pulmonary edema are analyzed morphologically. This series shows no single distinctive pattern differentiating the underlying causes of this condition. There was some correlation, however, between the massive central type of edema without congestive changes and uremia, and also between the poorly defined congestive type and cardiac failure without uremia. A roentgen pattern characteristic of pulmonary edema is not necessarily associated with the clinical signs usually ascribed to the condition.

Eight roentgenograms; 1 diagram; 3 tables.

MORTIMER R. CAMIEL, M.D.
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Lobar Emphysema. Eugene F. Van Epps and Dale H. Davies. *Am. J. Roentgenol.* 73: 375-386, March 1955.

Lobar emphysema is an obstructive emphysema of unknown etiology. The ballooning of the involved portion of lung displaces the contiguous structures and interferes with respiration. In infants, and rarely in children and adults, it is an acute respiratory emergency characterized by alarming attacks of dyspnea of increasing severity, with or without cyanosis. The resulting hypoxia is poorly tolerated by the young patients and may lead to neurologically demonstrable central nervous system damage in a short time.

Roentgenograms reveal an extensive degree of emphysema, lobar in distribution, with compression of the adjacent lobes and shift of the heart and mediastinum to the opposite side, as well as posteriorly, as a result of anterior herniation of the emphysematous lobe into the opposite hemithorax in the severe cases. The vascular pattern in the involved lobe is distorted and separated, and not as irregular and thin as the septa seen in cystic disease of the lung. The diaphragm is flattened and depressed, never elevated.

The roentgen findings have been confused with pneumothorax, atelectasis of the opposite side, tension cysts, cystic disease, foreign bodies, diaphragmatic hernia, agenesis, and bronchial plugging by thick viscid mucus in asthma and fibrocystic disease of the pancreas.

This acute respiratory emergency usually requires immediate lobectomy for cure. Individual evaluation, however, of the need for surgical correction must be made, since spontaneous regression of symptoms and signs is known to occur.

The authors report 3 cases of lobar emphysema, each occurring in the right middle lobe, and 1 case of cystic disease of the left upper lobe.

Fifteen roentgenograms; 3 photomicrographs.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

The Middle Lobe Syndrome and Its Relationship to Certain Aspects of Middle Lobe Disease. Richard H. Adler, Frank E. Mantz, Jr., and Paul F. Ware. *J. Thoracic Surg.* 29: 283-295, March 1955.

The term middle lobe syndrome has appeared with

increasing frequency in the literature, and there has been some ambiguity in its use. The diagnosis of the middle lobe syndrome should be made only with the following criteria present: (1) hilar or peribronchial lymphadenopathy (2) bronchostenosis, and (3) changes in the distal parenchyma produced by the bronchostenosis. The lymphadenopathy may be acute in nature and result in temporary mechanical bronchial compression, leaving no permanent parenchymal change. If acute bronchitis ensues secondary to lymphadenitis, edema may further narrow the compressed middle lobe bronchus. Peribronchial inflammation may result in permanent scarring and fibrosis of the peribronchial structures. If infection does not supervene, an atelectatic, middle lobe may be an incidental finding on a chest film.

The most common course is that of repeated bouts of infection leading to persistent lymphadenopathy, bronchial compression, and increased obstruction. Repeated episodes of this nature lead to severe damage to the parenchyma and bronchus, with ultimate bronchiectasis, chronic pneumonitis, fibrosis, lung abscess, bronchopleural fistula, and empyema.

The clinical diagnosis of middle lobe syndrome means little without a knowledge of the underlying etiologic agents producing it. In children tuberculous hilar adenopathy is often responsible. In the older age group the possibility of an underlying neoplasm simulating the complex must be considered. It can be produced, also, by histoplasmosis and sarcoidosis. Bronchoscopy and bronchography are valuable in demonstrating the obstruction of the right middle lobe bronchus.

In general, the treatment of this syndrome is surgical. Only rarely, when a benign etiology is established and the lesion proved to be stable, can the physician temporize by careful observation.

The authors present 5 cases of middle lobe disease. The first was an example of bronchiectasis of the middle lobe without evidence of bronchostenosis or peribronchial lymphadenopathy. This type of case is frequently referred to as middle lobe syndrome, but without the criteria of bronchostenosis and peribronchial lymphadenopathy this diagnosis is unjustifiable. In 1 of the cases sarcoidosis was responsible for a middle lobe syndrome. In another histoplasmosis was the cause.

Nine roentgenograms; 1 photomicrograph.

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Roentgenologic Diagnosis of Bronchiectasis. An Analysis of 112 Cases. Carl E. Gudbjerg. *Acta radiol.* 43: 209-226, March 1955.

While it is generally agreed that bronchiectasis may be demonstrated with certainty only by bronchography, the author believes that in most cases a well founded suspicion of the diagnosis can be gathered from a study of the ordinary roentgenogram. Bronchography will be required, however, in any case in which surgery is contemplated.

In this report, 112 cases studied by both methods are analyzed. In 66 instances there was operative confirmation of the diagnosis. Significant findings on the plain films were: increased pulmonary markings, found in 85 per cent; honeycomb-like structures in 43 per cent; atelectasis in 31 per cent; and pleural changes in 47 per cent. Normal appearing plain films of the chest were obtained in only 7.1 per cent of the cases.

The bronchographic findings are analyzed according to the site and type of dilatation. Comparison with the operative findings showed complete agreement.

Twenty-four roentgenograms; 6 tables.

J. R. MORRISON, M.D.
University of Arkansas

Contribution to the Radiological Study of Congenital Pulmonary Cysts in Children. Guido Lombardi. *Radiol. med. (Milan)* 41: 209-222, March 1955.

The Radiologic Picture of Pneumocoele in Children. Guido Lombardi. *Ibid.* 41: 365-376, April 1955. (In Italian)

Otherwise inevitable infectious complications are avoided by early resection of localized congenital pulmonary cysts in children, the results usually being satisfactory, as illustrated by 4 cases reported in the first of the two papers cited above. This emphasizes the need for accurate interpretation of what is often an asymptomatic x-ray finding.

The rare *closed cyst* appears as a rounded, well circumscribed density. As soon as bronchial patency supervenes, the milky, albuminous content is evacuated, but a small level may persist for some time, even in the absence of secondary infection. Otherwise, a fluid level, especially if associated with general inflammation, calls for differentiation from a *pulmonary abscess*. This is effected by contrasting the well defined cyst wall with the irregular, necrotic contour of the abscess. While small hemoptyses are sometimes encountered in congenital cysts, a *tuberculous cavity*, not very common in children, can be recognized by the surrounding and/or added infiltration, and by bacteriologic studies. Inflation of the cyst by a valve mechanism can fill a hemithorax with air, causing dyspnea and simulating a *pneumothorax*, although in the latter case we expect to see the collapsed lung crowded around the hilus. A *transdiaphragmatic hernia* should be easily ruled out by barium meal. *Post-traumatic pulmonary cysts*, called "encapsulated intraparenchymal pneumothoraces," are the result of lung laceration, and usually heal without visible sequelae; if they persist as a result of a valve action of the draining bronchus, there is always the history of previous trauma.

Congenital cysts are solitary in one-third of the cases, and most often located in the upper lobes. Being developmental abnormalities of the bronchial tree, they are at times extrapulmonary, *i.e.*, intramediastinal or intrapleural. *Emphysematous bullae* are always multiple, usually distributed in the bases. In children they are caused by a proximal (incomplete) central obstruction, such as tracheobronchial adenopathy. As opposed to congenital cysts, emphysematous bullae are very seldom secondarily infected, but are fairly often complicated by spontaneous pneumothorax.

The term *pneumocoele* is reserved for the cystic structures which appear during acute pneumopathies and disappear spontaneously, as in 4 cases reported in the second of the two papers listed above. If, however, a bronchial valve mechanism becomes established, they may persist, in which event differentiation from congenital cysts is of only academic interest, since surgical removal is recommended.

The first of these papers is illustrated by 19 roentgenograms and 3 photographs; the second by 16 roentgenograms.

E. R. N. GRIGG, M.D.
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A New Roentgen Sign of Malignancy in the Solitary Pulmonary Nodule. Leo G. Rigler. *J.A.M.A.* 157: 907, March 12, 1955.

Isolated rounded shadows, often called coin lesions, are found on chest roentgenograms with increasing frequency. Their differential diagnosis is difficult. A sharply defined contour or the presence of calcium, either of which is best demonstrated by body-section roentgenography, is indicative of a benign process, although not an infallible sign. The author cites a new roentgen sign of malignancy, consisting in a notching or umbilication of a border of the shadow. It is occasionally detected on conventional roentgenograms, but is visualized best on laminagrams. For a fuller account of this new finding, see Rigler and Heitzman: *Radiology* 65: 692, 1955.

Two roentgenograms.

B. JAY HILL, M.D.
University of Michigan

Mass Roentgenographic Screening as a Lung-Cancer-Control Measure. Lewis W. Guiss. *Cancer* 8: 219-236, March-April 1955.

In 1950, 1,867,201 miniature chest roentgenograms were made in the Los Angeles County x-ray survey. Of these, 3,500 (1.9 per 1,000) were reported as suspicious of chest tumor. In this "suspect" group, 80 per cent proved to have definite disease of some type. Seven hundred and fifty-four (20 per cent) had neoplasms, about one-half of which were benign and one-half malignant. Two hundred and thirteen had bronchogenic carcinoma. Ninety-six cases of metastatic cancer were encountered; in most of these the patients were previously aware of their disease.

Most of the bronchogenic carcinomas were initially discovered by the survey. However, 27 patients who had minifilms taken died later in the year from bronchogenic carcinoma which was not discovered.

Sixty-seven per cent of the examiners' effort was expended in screening those under forty-five years of age. This group yielded but 9 per cent of the lung cancers. It is suggested by the author that, if the survey were restricted to males over forty-five, the relative number of lung cancers discovered would be increased four, to fivefold in Los Angeles. In addition, the cost of such a selective survey would be reduced from the \$6,220.00 per lung cancer in this survey to about \$300.000 per lung cancer found.

Thirty-one tables. DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

Surgical Treatment of Lung Cancer Found on X-Ray Survey. Richard H. Overholt, James A. Bougas, and Francis M. Woods. *New England J. Med.* 252: 429-432, March 17, 1955.

Forty-six patients among 1,100 with histologically verified lung cancer seen at the Overholt Thoracic Clinic (Boston) were completely asymptomatic at the time their lesions were discovered by x-ray survey of the chest. The patients did not all come immediately for treatment, however, and in 18 patients symptoms had developed by the time they were seen for consultation.

Thirty of the 46 patients had been seen more than three years prior to the report. Of these, 9 were alive and well without evidence of recurrence at the conclusion of the three-year period. This 30 per cent survival rate represents a distinct advance over the 12 per cent three-year survival for symptomatic cases. Of the 9 "cured" patients, 5 were treated within six weeks of the

x-ray survey and 1 at four months; 3 were treated less promptly but were found to have bronchiolar carcinoma, which is a slow-growing, more favorable type of tumor.

The authors recommend further use of mass surveys and other x-ray studies of the chest as a means of discovering lung carcinomas before they become extensive or cause symptoms. They believe that all men more than forty years of age should have x-ray examination of the chest at least annually, and preferably semi-annually if they are heavy cigarette smokers. Their 46 cases constituted 18 per cent of 286 patients who were explored for abnormal pulmonary shadows discovered on x-ray survey.

The commonest x-ray appearance is that of the spherical, "coin-shaped" lesion. Satellite nodules, smooth outline, and lack of demonstrable change over a period of months or even years do not rule out cancer. Diffuse calcification throughout the lesion is usually a dependable criterion of benignancy.

The authors recommend the direct approach to the diagnosis of asymptomatic lung lesions. Thoracotomy is indicated when diagnosis cannot otherwise be made. Bronchoscopy is valuable only when positive, and in silent lesions is rarely successful diagnostically.

Four roentgenograms; 1 chart; 1 table.

ARTHUR S. TUCKER, M.D.
Cleveland Clinic

Comparison of Roentgenographic and Surgical Findings in Tuberculosis. Charles E. Schmidt. *Am. Rev. Tuberc.* 71: 452-456, March (Part 1) 1955.

Preoperative roentgenographic appraisals were compared with operative findings in 165 cases of pulmonary tuberculosis. The main failures in prediction were found to be in the distribution of the disease. These occurred in 18 per cent of the series, most often in cases with widespread involvement. The anterior upper lobe segments and posterior basal segments were most difficult to evaluate.

The prediction of cavitation was accurate in all cases where cavities proved to be present. In 8 per cent of cases cavities were predicted but not discovered at surgery.

It was found that, if more reliance had been placed on the x-ray findings, surgery might have been prevented in 12 patients (7 per cent) in whom the disease was insignificant. On the other hand, positive tuberculous lesions were found in 2 cases where the disease was predicted to be insignificant.

In these analyses rather strong reliance was placed upon heavily exposed lateral planigrams.

Eleven roentgenograms.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

The Wisconsin State Board of Health Mobile Unit X-Ray Surveys (1949-1951); A Report of 494,442 70 mm. X-Rays, 19,579 Referrals. Milton Feig and Agnes Jensen. *Wisconsin M. J.* 54: 151-160, February 1955.

The material presented is a portion of the data studied by the Wisconsin State Board of Health in the process of evaluating and improving its mobile unit surveys as a screening device for the detection of tuberculosis and other diseases. During the period 1949-1951, 492,442 70-mm. films were taken; a subsequent six-month follow-up study was also made.

Referrals to physicians, based on the screenings, were for: (1) suspicious tuberculosis; (2) apparent tuberculosis, including minimal, moderately advanced, far advanced; (3) pathology of undetermined etiology. The number of persons referred was 19,579, constituting 4.0 per cent of the total; 13,415 of these (68.5 per cent) were examined by their physicians. The findings in this latter group are listed as follows: negative (including healed primary lesions); definite tuberculosis in various classifications; heart disease; cancer; pathology of undetermined etiology; other abnormalities. Almost 60 per cent of those examined were considered negative. Over 40 per cent had evidence of definite disease, a figure which the authors consider significant in view of the fact that the 70-mm. film is a screening and not a diagnostic device. In the detection of tuberculosis the order of productiveness for the screening groups, based on rates for each group, was apparent tuberculosis, suspicious tuberculosis, and pathology of undetermined etiology. The last-named group is by far the most significant with regard to cancer detection, and it has been the most neglected in examination following referral.

Three graphs; 5 tables.

Tuberculosis Studies in Muscogee County, Georgia.
IV. Evaluation of a Community-Wide X-Ray Survey on the Basis of Six Years of Observations. George W. Comstock and Philip E. Sartwell. *Am. J. Hyg.* 61: 261-285, March 1955.

Pulmonary tuberculosis morbidity among persons examined in a community x-ray survey is evaluated on the basis of six years of observation. The recognition of active tuberculosis was increased considerably by diligent follow-up of survey suspects. Persons with active disease at some time during the study period comprised 0.30 per cent of the x-rayed population, a prevalence ratio about three times as great as that obtained from the initial follow-up in many mass surveys. [The original report of this project appeared in *Public Health Reports* 64: 259, 263, 1949 (Abst. in *Radiology* 54: 295, 1950).]

Among the group initially selected for follow-up because of x-ray findings, 12 per cent of the whites and 24 per cent of the Negroes showed definite evidence of active disease. For both races, prevalence of pulmonary tuberculosis increased with age; except for Negro females, the prevalence of active disease was also greater after forty-five than among younger persons.

Nine per cent of subsequently identified cases were missed in the initial reading of the films, although dual readings were employed. On the other hand, 30 per cent of the original group to be followed were later considered non-tuberculous.

New cases of tuberculosis were detected at a fairly steady rate following the survey. During the subsequent five years, tuberculosis developed in 34 white persons and 76 Negroes whose chest films were negative at the time of the survey. Of these, 14 white persons and 46 Negroes showed evidence of active disease following detection. This represents an average annual incidence rate for active tuberculosis of 0.14 per 1,000 population for whites and 0.72 for Negroes. In males, the incidence was as high above as below forty-five years; in females it was higher below forty-five.

As a limited evaluation of mass surveys, this study reveals several common deficiencies. Nevertheless,

with intensive follow-up of discovered cases and active search for new cases, both in the survey-negative and unexamined segments of the population, mass surveys are believed to form a valuable part of the tuberculosis control program in a community.

Five charts; 17 tables.

Photofluorography at a U. S. Naval Shipyard.
Warren R. Guild. *J.A.M.A.* 157: 1003-1005, March 19, 1955.

This report covers the 1953 survey of civilian employees at the New York Naval Shipyard, for tuberculosis detection. A total of 20,379 70-mm. photofluorograms were studied. The annual survey of employees, limited to those with normal photofluorograms previously, accounted for 18,146, pre-employment screening for 2,161, and separation or retirement studies for 72 (presumably with normal photofluorograms on previous surveys). All photofluorograms were read initially at the Naval Shipyard and subsequently at the Bureau of Medicine and Surgery in Washington, D.C. All doubtful cases were checked by 14 X 17-inch films.

Abnormalities were found in 9.9 per cent of all photofluorograms. In only 3 per cent were the abnormalities considered to warrant 14 X 17-inch films. In 134 cases (0.66 per cent of the total) further clinical study was required. Findings in this latter group are tabulated as to diagnosis. There were 5 cases of active tuberculosis, 3 in the annual and 2 in the pre-employment survey. One bronchogenic carcinoma was discovered.

B. JAY HILL, M.D.
University of Michigan

Roentgenologic Aspects of Silicosis and Asbestosis.
Leonard J. Bristol. *Arch. Indust. Health* 11: 189-195, March 1955.

Silicosis and asbestosis result from the inhalation of free crystalline quartz silica and asbestos fiber. The diagnosis rests upon (1) an adequate history of exposure and (2) demonstration of a characteristic, though varying, pattern in the chest roentgenogram.

Silicosis is classified into three groups, depending upon the extent of the characteristic shadows: (1) simple silicosis of first, second, and third degree; (2) silicosis with conglomeration; (3) silicosis with tuberculosis. In simple silicosis, Stage I, there is a fine pulmonary nodulation, barely visible roentgenographically, with preservation or exaggeration of the linear markings. Stage II is characterized by 2 to 3-mm. nodules that obscure the linear markings, and Stage III represents nodular pulmonary infiltration in excess of 3 mm. diameter with coalescence.

Diffuse obstructive emphysema nearly always complicates conglomerate silicosis, but rarely complicates the discrete nodular form. Fluoroscopy of the chest and a chest roentgenogram in full expiration are suggested to evaluate pulmonary function impairment of any magnitude.

Accentuation of the hilar regions, which is said to be present always in simple silicosis, helps differentiate it from siderosis.

Pulmonary function impairment in asbestosis results from a "tight lung" and not from obstructive emphysema; therefore, chest fluoroscopy and roentgenography are of little value in determining the ventilatory defect (no increase in residual air).

Asbestosis is divided into three stages, depending upon the extent of involvement, clarity of the cardiac

borders, and portions of the lung fields involved. Stage I is represented by a fine network of densities principally in the lung bases, Stage II by an extension of this pattern peripherally, with obliteration of the sharp cardiac borders and a parenchymal "ground-glass" appearance, and Stage III by a further accentuation of the parenchymal densities, with extension into the upper lung fields. In asbestosis, unlike silicosis, x-ray changes may be slight in the presence of definite functional impairment.

In a discussion of this paper, Dr. M. C. Sosman outlined the problem of diagnosing silicosis and asbestosis in a general hospital, where there is a wider variety of disease and a less definite history of exposure than at the Trudeau-Saranac Institute from which this report came. Symptoms similar to those of the pneumoconioses may be due to disease elsewhere in the body, and various pulmonary diseases and conditions can imitate one another.

Ten roentgenograms; 1 graph; 1 drawing.

PAUL W. MATHEWS, JR., M.D.
University of Texas, Dallas

The Submersion Syndrome. Myron Saline and George L. Baum. *Ann. Int. Med.* 41: 1134-1138, December 1954.

The authors report the case of a patient recovering from submersion and tabulate the observations in 26 cases for which they had clinical records.

The submersion syndrome is usually a rather benign transitory process, the severity of which is related to the degree of hypoxia experienced during the submersion. The symptomatology is variable. Gastrointestinal symptoms consist of abdominal distention, nausea, and vomiting. Neurological findings range from transitory restlessness to vertigo, confusion, or unconsciousness. Pulmonary findings are those of edema and congestion. Roentgen changes are commonly related to the chest: transitory pulmonary densities and manifestations of patchy pulmonary edema, lasting two to three days.

Two roentgenograms; 1 table.

RICHARD E. OTTOMAN, M.D.
University of California, L. A.

Labile and Migratory Pulmonary Infiltrate with Eosinophilia. Etienne Bernard and Ch. Wolff. *J. franç. méd. et chir. thorac.* 9: 136-142, 1955. (In French)

A 34-year-old man complaining of nocturnal asthmatic episodes was found to have an infiltrate in the right upper lobe which migrated to the left mid-lung field and then to the left lower lung field in about six weeks. Studies for tubercle bacilli were negative. The eosinophil count of the blood ranged from 60 per cent down to 10 per cent. Stool studies revealed only oxyuria and cysts of *Lambia*. Subsequently the roentgenographic lung changes cleared completely, the nocturnal asthmatic episodes decreased, and the eosinophil count fell to 8 per cent. Stool studies revealed no parasites.

The patient seems to have improved under anti-parasite therapy, but no definite proof of parasitic infestation was ever obtained. The etiology was considered unknown.

Seven roentgenograms.

CHARLES M. NICE, JR., M.D.
University of Minnesota

Cervical Hernia of the Lungs. Constantine J. Falliers. *J. Pediat.* 46: 332-336, March 1955.

The literature on pulmonary hernia is reviewed and a case is reported of what is believed to be the spontaneous development of bilateral cervical herniation of the lungs in a girl of two and a half years.

Pulmonary hernias may be congenital or acquired as a result of trauma, wound healing, increasing intrathoracic pressure, an inflammatory process, or a neoplasm. In location, they may be cervical, thoracic, or diaphragmatic. Cervical herniation is commonly considered to be congenital.

In the case reported here, it was felt that the cervical herniations resulted from a congenital weakness of Sibson's fascia aggravated by a chronic intermittent spasmodic increase in intrathoracic pressure due to recurrent spells of coughing. Roentgenographic and roentgenoscopic examinations showed both the lungs ballooning up above the clavicles into the low anterior neck with coughing. After the coughing was successfully controlled and straining avoided, the degree of herniation seemed to decrease over a follow-up period of nearly three years.

Four roentgenograms; 2 photographs.

H. G. PETERSON, JR., M.D.
New Britain, Conn.

Diagnostic Difficulties in Evaluating Pulsating Mediastinal Masses. Charles K. Donegan and Don C. Nouse. *J.A.M.A.* 157: 798-801, March 5, 1955.

The authors report 5 cases of pulsating mediastinal masses. All were asymptomatic and originally detected on routine roentgenographic studies. They were originally diagnosed as aneurysms.

Two of the masses proved to be cystic thymomas (a rare finding in the adult); 1 was a simple serous cyst, 1 an aneurysmal dilatation of the pulmonary artery, and 1 an anomaly of the left pulmonary artery felt to be of no clinical significance. It is of interest that the 3 tumors were all cystic.

It is evident from this small series that some tumors will show definitely expansile pulsation because of close proximity to the larger arteries. On the other hand, arterial anomalous shadows may not pulsate vigorously.

The authors stress the diagnostic value of angiocardiology, which they consider safer than exploratory thoracotomy. In 2 of their cases angiocardiology demonstrated the vascular nature of the lesion and exploration was avoided.

Five roentgenograms; 3 photographs.

B. JAY HILL, M.D.
University of Michigan

Mediastinal Emphysema in the Newborn. Arturo J. Aballi, Olimpo Moreno, Oscar Sanchez Beltran, Juan Alonso Fontao, Lino Boudet, and A. Don Varona. *Rev. cubana de pediat.* 26: 629-654, October 1954. (In Spanish)

The authors present 10 cases of mediastinal emphysema, 6 of which were fatal and confirmed postmortem. In these cases the most common etiologic factor was aspiration of amniotic fluid. In 3 instances it would have been possible to intervene by the administration of oxygen under pressure, and in 1 case by puncture of the internal jugular. All the patients were children *in extremis*, and in 77 per cent birth was complicated by dystocia.

From the clinical point of view, the most important findings in the diagnosis of mediastinal emphysema in the newborn are abolition of the heart sounds, augmentation of substernal resonance, and barrel chest. Dyspnea is an almost constant symptom. Cyanosis and the manifestations of collapse constitute the most significant indices of the gravity of the process.

The roentgen examination is indispensable for confirmation of the diagnosis, the lateral film being most useful. In the anteroposterior view the presence of a border zone of air contiguous to the cardiac silhouette is a sign of some value, but it has been observed in only a few cases. Associated pulmonary lesions are often present.

The authors outline a method of treatment which has transformed failures into successes.

Six roentgenograms; 3 photographs; 1 photomicrograph; 3 tables.

JAMES T. CASE, M.D.
Santa Barbara, Calif.

Hilar Lymph Nodes in Chronic Pulmonary Stasis. Pietro Del Buono and Luigi Martino. *Arch. di radiol.* 29 (n. s. 3): 89-100, 1954. (In Italian)

Nodular densities seen in the hili of patients with chronic mitral disease are usually interpreted as dilated lung root arteries, projected in cross section. On the basis of autopsy material, the authors affirm that, whenever passive pulmonary congestion has existed for a certain length of time, at least some of these hilar nodules represent bronchial (intrapulmonary) lymph nodes which have become radiopaque because of enlargement, engorgement, and siderosis. While enlargement of the left atrium may subside to a certain extent, the hemosiderotic lymph node persists indefinitely as evidence of previous edematous and hemorrhagic episodes. Both the "cardiac pneumolymphadenopathy" and the "left atrial ectasia" are well demonstrated by body-section radiography.

Two roentgenograms; 1 drawing.

E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

THE CARDIOVASCULAR SYSTEM

Diagnostic Roentgenology in Congenital Heart Disease. Martin H. Wittenborg and Edward B. D. Neuhauser. *Circulation* 11: 462-485, March 1955.

Appearing under the general heading "Clinical Progress," this paper offers a comprehensive survey of the literature on the roentgen diagnosis of congenital heart disease, with comments and examples from the authors' own experience. It is recommended in the original as an excellent up-to-date summary of all aspects of the subject. It is emphasized that roentgen findings alone are scarcely ever sufficient for diagnosis but must be correlated with information gained by other means.

The fetal circulation is unembarrassed by most congenital lesions, so that, with few exceptions (primary myocardial disease, aortic atresia, and congenital arteriovenous aneurysms), cardiac enlargement is not observed at birth. Soon thereafter, however, selective chamber hypertrophy begins, long before an adult configuration is attained. This makes for a fundamental difference in the diagnostic features, well illustrated by the right ventricle. Thus, in congenital lesions, enlargement of the right ventricle is demonstrated in the postero-anterior view by a lifting of the

cardiac apex, which assumes a rounded appearance, while in acquired disease it is manifested as a forward bulge in the right anterior oblique view.

The caliber of the pulmonary vessels as observed on the roentgenogram must be carefully noted, as well as their pattern. Diminished caliber usually means pulmonary stenosis but occurs also in tricuspid atresia or stenosis, Ebstein's disease, and anomalous insertion of a vena cava into the left atrium. Increased size may be passive, active (left-to-right shunt), or poststenotic (confined to the main trunk). The pattern is important in differentiating between normal pulmonary vessels and collateral circulation through the bronchial arteries.

Congenital heart disease is best classified according to the presence or absence, or late appearance, of cyanosis. In this last group a reversal of the flow through a left-to-right shunt may be assumed, usually in association with pulmonary hypertension.

Of the acyanotic group, coarctation of the aorta is about the easiest to diagnose, showing rib notching (present also in other anomalies), poststenotic dilatation, and upper limb hypertension. It is not widely known that coarctation can cause congestive failure in infancy, giving a picture closely resembling primary myocardial disease.

Congenital aortic and subaortic stenosis are not usually diagnosed radiologically until late in life, when valve calcification, aortic widening, and left ventricular enlargement may be seen.

Pulmonic stenosis, when mild, may produce no abnormal x-ray findings, but as the condition becomes more severe the pulmonary markings diminish in caliber and the right ventricle and later the right atrium show enlargement. In so-called "pure" (uncomplicated) pulmonic valvular stenosis the main pulmonary artery may show poststenotic dilatation.

Small defects in the atrial and ventricular septa may also be without abnormal x-ray findings. In interauricular defects of sufficient magnitude to produce roentgenographic changes, right ventricular enlargement will always be recognized. Larger shunts will sooner or later be reflected by increased prominence of the pulmonary vascular markings, and there may be prominence of the atria, especially the right. In interventricular defects it is not uncommon to see prominence of the right ventricle on the roentgenogram and dominance of the left ventricle on the electrocardiogram. If pulmonary vascular engorgement is present, the left atrium will reflect the increased blood flow by slight prominence.

A patent ductus arteriosus produces enlargement of the left atrium and ventricle, and of the pulmonary artery and branches. Fluoroscopically there is a hyperactive beat of the left border, aorta, and pulmonary artery. This is another condition to be considered in an infant in congestive failure with a large heart and no cyanosis. Aortic pulmonic fenestration cannot be distinguished from patent ductus by roentgenologic means, since the physiologic results are identical. Similarly, large or high ventricular septal defects, which place the same load on the heart as patent ductus, present comparable x-ray changes.

Development of pulmonary hypertension complicating any of the last three conditions (patent ductus, aortic pulmonic fenestration, or large or high ventricular septal defects) causes reversal of flow through the shunt, producing "late" cyanosis. In the case of the

ventricular defect this constitutes "Eisenmenger's complex."

Of the cyanotic group of heart lesions with survival for a year and a half or more, 60 to 70 per cent are tetralogy of Fallot. Tricuspid atresia, truncus arteriosus, and transposition make up most of the remainder. In the cyanotic group there is one finding to be looked for, namely, diminished lung markings, since these cases can be helped by surgery no matter what the basic lesion.

In tetralogy of Fallot there is a wide range of appearances, from a normal silhouette to extreme right ventricular enlargement. The pulmonary vasculature, except in the exceedingly mild cases, is almost uniformly diminished. If the patient survives a number of years, considerable collateral circulation through the bronchial arteries usually develops, and at first glance, this may mask the apparent diminution in the pulmonary blood flow. A few cases of unilateral pulmonary atresia with tetralogy have been seen, and in these, of course, the single remaining artery cannot be occluded for anastomosis. Right aortic arch is seen in about 25 per cent of the cases.

Tricuspid atresia should be easily differentiated, since it has no less than three pathognomonic features: (1) a distinctive silhouette, showing absence of mass where one expects to see right ventricle, (2) electrocardiographic evidence of left ventricular hypertrophy in the presence of cyanosis, (3) asynchronous pulsation, in the left anterior oblique position, of the anterior and posterior borders. One or more of these signs is usually present in any given case. Dextroposition or dextrocardia, as well as reversed position of the aortic arch, occurs in 30 per cent.

Pulmonic stenosis with atrial communication is a combination which may cause cyanosis from birth or later. The right ventricle and atrium are enlarged and the lung vessels diminish.

Ebstein's disease is usually associated with an atrial septal defect through which there will be a right-to-left shunt by reason of the high pressure in the right atrium. There is great enlargement of the right atrium but diminished prominence of the pulmonary artery and branches.

Truncus arteriosus communis presents engorgement of the pulmonary vessels but an absence of a recognizable main pulmonary artery.

Transposition of the great vessels has many variations, most of which prove fatal early in infancy. All show an abnormal relationship of the great vessels in either postero-anterior or oblique views. Other features depend on whatever shunts exist to permit the admixture of the two circulations necessary to maintain life.

Anomalous insertion of a vena cava into the left atrium is another cyanotic condition, but this can be diagnosed only by angiocardiology.

Anomalous pulmonary venous return shows a characteristic widening of the superior mediastinum, with a "figure of 8" silhouette.

Primary myocardial disease of whatever origin (glycogen storage disease, aberrant left coronary artery, medial necrosis of the coronary arteries, subendocardial sclerosis, and idiopathic myocarditis) shows cardiac enlargement, electrocardiographic abnormalities, no significant murmurs, and normal blood pressure.

Vascular rings or single anomalous arteries (usually the right subclavian) may produce significant compression of the trachea or esophagus or both.

A few general remarks are included on angiocardiology and retrograde aortography.

Twenty-one roentgenograms; 2 figures; 2 tables.
ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Studies in Angiocardiology: The Problem of Injection. Presentation of a High-Pressure Automatic Injecting Machine to Meet the Needs of Modern Angiocardiology. Antonio Rodriguez-Alvarez and Narno Dorbecker. *Am. Heart J.* 49: 437-454, March 1955.

If good angiocardiological roentgenograms are to be obtained with modern long, narrow-bore cardiac catheters, high injection pressures must be used in order to obtain optimal flow rates of radiopaque substances. A machine was devised by the authors to fulfill this basic requirement with the maximum of safety, with optimal injecting pressures, and with fully automatic synchronization of injection, x-ray exposure, and cassette changing. A detailed description of this injecting device is presented.

The different technics and apparatus used by others for injection, and the physical principles upon which they are based, are briefly analyzed, together with some of the hemodynamic variables obtained in different "organ-hosts."

Seven illustrations.
HOWARD L. STEINBACH, M.D.
University of California, S. F.

A Critical Evaluation of the Roentgen Criteria of Right Ventricular Enlargement. Marcy L. Sussman and George Jacobson. *Circulation* 11: 391-399, March 1955.

Their experience with angiocardiology led the authors to question the commonly accepted criteria of right ventricular enlargement, namely, (1) bulging of the outflow tract into the lung-filled triangle of the anterior mediastinum, seen earliest in the right anterior oblique position; (2) filling in of the concavity in the left cardiac border below the aortic knob, in the postero-anterior view; (3) anterior bulging of the lower part of the contour, seen in the left anterior oblique. On the basis of these three points, four groups of cases with proved right ventricular enlargement were evaluated by each of the authors independently.

Group 1 consisted of 8 cases of pure pulmonic stenosis; 5 were considered normal by both readers. In the other 3 there was agreement as to the presence of enlargement but a difference of opinion as to its degree.

Group 2, comprising 11 cases of pulmonic stenosis with less than 90 per cent arterial oxygen saturation (suggesting a complicating right-to-left shunt), yielded about the same results as to the number satisfying the criteria for right heart enlargement and as to agreement between the authors.

Group 3 consisted of 23 cases of pulmonic stenosis with catheter evidence of a complicating shunt. In only 6 of these could right heart enlargement be diagnosed roentgenographically.

Group 4 was made up of 25 cases in which the tetralogy of Fallot was the basic lesion. In 15 of these the authors agreed that there was no evidence of right heart enlargement.

In all groups the electrocardiogram was found to be a much more consistent indicator of right heart enlargement than the roentgenogram.

It is concluded that the usual criteria of right heart enlargement were of little value in this series of cases, with the stipulation that the group included very few infants. [The point should have been made also that all the cases were of congenital origin, whereas the criteria were established chiefly by the study of acquired heart disease in which the heart develops normally for some period of time before the cause of enlargement appears.—Z.F.E.]

Four tables.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

The Demonstration of Left Atrial Enlargement by Body Section Radiography. Bernard H. Pastor, George T. Wohl, and L. Theodore Lawrence. *Circulation* 11: 400-403, March 1955.

It is well known that an enlarged left atrium may sometimes be difficult to demonstrate on routine roentgen studies. The authors used body-section roentgenography and obtained clear delineation of the enlarged atria in both oblique and postero-anterior views. The procedure was also helpful in revealing widening of the tracheal bifurcation and compression of the left main bronchus.

Several cases are illustrated in which the usual films did not clearly show the enlargement while the body-section films did.

Nine roentgenograms. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

The Diagnosis of Bundle Branch Block by the Kymographic Method. Ismet Sayman. *Presse méd.* 63: 357, March 9, 1955. (In French)

Contrary to common opinion, bundle branch block may be detected by means of roentgenkymography. The number and type of pulsations along the left inferior cardiac border (left ventricle) may be compared to observations of the inferior third of the right cardiac border or the upper portion of the left cardiac border. The inferior third of the right cardiac border shows pulsations transmitted to the right atrium by the right ventricle. The upper third of the left cardiac border shows pulsations transmitted by the pulmonary conus region.

There may be a difference in the number of pulsations transmitted by the left and right ventricles, as well as a difference in timing. The form of pulsation also differs, the blocked ventricle giving pulsations of triangular shape with pointed apex.

Five diagrammatic sketches illustrate these changes.

CHARLES M. NICE, JR., M.D.
University of Minnesota

The Ventricular Pulsations in Myocardial Infarction; a Fluoroscopic and Kymographic Study. Simon Dack. *Dis. of Chest* 27: 282-297, March 1955.

At fluoroscopy the normal heart shows an inward movement of the lower left border in systole and outward in diastole. The arterial segment above the "point of no pulsation" shows opposite movements. After myocardial infarction a segment of varying size may show diminution, absence or reversal of ventricular pulsation. Usually these findings are best detected in the postero-anterior view, regardless of the location of the infarction. In some cases of anterior infarction, reversal of pulsation may be brought out by rotating the patient to the right anterior oblique, and a few pos-

terior lesions are better seen in the left anterior oblique, but these are the exceptions.

The abnormal movements are often present in the first week and almost always in the second week after the attack. Graphic methods, either roentgen or electrokymographic, are more sensitive than fluoroscopy in making the diagnosis and afford leisurely study. Fluoroscopic diagnosis is especially difficult when the amplitude of the movements is small.

Ten electrokymographs; 4 drawings.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Primary Hemangioendotheliosarcoma of the Heart, Diagnosed by Angiocardiography. Review of the Literature and Report of a Case. Tsung O. Cheng and Don C. Sutton. *Circulation* 11: 456-461, March 1955.

The authors report a case of hemangioendotheliosarcoma of the heart, the eighth in the literature and the first in which the diagnosis was suggested antemortem by angiocardiography. Malignant primary cardiac tumors have a predilection for the right atrium, while the benign myxomas are seen mostly in the left atrium. The location favors the diagnosis by angiocardiography because of the high concentration of the medium in the right atrium.

The diagnosis of a primary malignant tumor of the heart was suspected in the authors' patient because of the exclusion of other causes of severe progressive heart failure in a previously healthy individual. It was confirmed by the demonstration of a constant filling defect in the right atrium at angiocardiography. [A previous antemortem diagnosis, by pneumopericardium, has been reported by Lübschitz, Lundsteen, and Forchhammer in *Radiology* 52: 79, 1949.]

Three roentgenograms; 1 photograph; 3 photomicrographs.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Focal Pulmonary Hemosiderosis in Rheumatic Heart Disease. Michael J. Eposito. *Am. J. Roentgenol.* 73: 351-365, March 1955.

Pulmonary hemosiderosis refers to the intra-alveolar deposition of the iron-containing pigment, hemosiderin, which is derived from the decomposition of extravasated red blood cells and is usually found within phagocytic cells. In most instances of chronic passive congestion these "heart-failure cells" are scattered throughout the alveoli. However, they may cluster in small compact foci, constituting so-called "focal pulmonary hemosiderosis." These aggregates may become large enough to be seen on the roentgenogram. This occurs in two distinct clinical states: (1) in chronic failure of the left heart due to any cause but usually the result of rheumatic heart disease associated with mitral stenosis; (2) in idiopathic pulmonary hemosiderosis, a frequently fatal disease of unknown etiology, seen almost exclusively in children and characterized by recurrent episodes of fever, dyspnea, cyanosis, hemoptysis, and anemia.

A study of 100 autopsied cases of rheumatic heart disease disclosed 28 examples of focal hemosiderosis. With the exception of 4 cases due to aortic narrowing, all were the result of mitral stenosis. The condition could be recognized roentgenographically in 5 of the 6 advanced cases.

The essential roentgenologic feature is a diffuse, fine, granular pulmonary nodulation, nearly always asso-

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ciated with an enlarged heart bearing a mitral configura-
tion. The nodules are irregular in outline and measure
between 2 and 4 mm. in greatest diameter. On occa-
sion they may be as large as 5 mm. They are con-
centrated in the mid-zones, but may extend toward
the periphery in all directions. The apices are usually
but not invariably spared. The nodules of hemosidero-
sis have never been observed to disappear or to decrease
in size.

Pulmonary congestion tends to obscure the miliary
nodules and is of itself able to produce a pseudonodu-
larity in the lung fields. Fortunately, the changes are
often of a transient nature. In addition, the nodularity
is primarily in the parahilar areas and fades out as the
vessels course peripherally. In contradistinction to
this, the aggregates of hemosiderin are often clearly
visible in the outermost lung fields. It is the presence
of these nodules beyond the confines of any conspicuous
vasculature that is diagnostic.

In addition to simple pulmonary congestion, the dif-
ferential diagnosis includes the many diseases that can
produce a miliary pulmonary infiltration. The more
common are miliary tuberculosis, the pneumoconioses,
sarcoidosis, and metastatic carcinoma. Each of these
may at times reveal certain features that are not to be
expected with hemosiderosis, but in many instances the
appearance will be indistinguishable. In all cases an
enlarged heart, especially with a mitral silhouette,
should serve to arouse one's suspicions. In the final
analysis, recourse to the history and clinical status will
be necessary to differentiate the various conditions.

Ten roentgenograms; 13 photomicrographs; 1
photograph.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

**The Clinical Estimation of Pulmonary Hypertension
Accompanying Mitral Stenosis.** Noble O. Fowler,
William J. Noble, Salvatore J. Giarratano, and Edgar
P. Mannix. *Am. Heart J.* 49: 237-249, February
1955.

Forty patients with rheumatic heart disease and
mitral stenosis were studied in an attempt to develop
clinical criteria for the estimation of the degree of pul-
monary hypertension, which is one of the major factors
determining the desirability of surgery in this condition.
The authors had in mind the avoidance of direct pres-
sure readings through venous cardiac catheterization
because this procedure, as they indicate, "is time-con-
suming, expensive, and not without hazard." Their
study includes a history, physical examination, labora-
tory tests, electrocardiography, roentgen examination,
and cardiac venous catheterization. In the history,
special attention was paid to hemoptysis, paroxysmal
nocturnal dyspnea, and right-sided heart failure. In the
physical examination, the intensity of the pulmonic
second sound was evaluated, as well as the intensity of
the apical diastolic murmurs. The electrocardiogram
was studied for evidence of right ventricular hyper-
trophy and right axis deviation. The roentgenographic
examinations included posterior and oblique views,
which were evaluated for right ventricular enlargement.
Cardiac venous catheterization was performed in the
customary manner, and pressure was recorded by
means of Sanborn electromanometers and the Poly-
Viso direct writing electrocardiograph. Mean pres-
sures were determined by planimetry.

The 40 patients were divided into three groups ac-
cording to the mean pulmonary pressures. Those with

pressures varying from normal through 29 mm. Hg were
considered to have no pulmonary hypertension or mild
hypertension; those with pressures from 30 to 49 mm.
Hg as having moderate pulmonary hypertension; and
those above 50 mm. Hg as having severe hypertension.
The authors concluded that it was impossible to evalu-
ate right atrial systolic peak pressure as a guide to pul-
monary hypertension.

The x-ray evidence of right ventricular hypertrophy
was usually marked in the severe group and occasion-
ally so in the mild group. Small hearts may, however,
be associated with severe hypertension. Electro-
cardiographic evidence of right ventricular hyper-
trophy, especially in precordial lead V, was very helpful
in suggesting fairly marked pulmonary hypertension.
The precordial lead V seemed a more sensitive indicator
of right ventricular hypertrophy than did the presence
of right axis deviation or an abnormal axis deviation
index. The intensity of the apical diastolic murmurs
and of the pulmonary second sound were of no help.

Right ventricular failure was found with increasing
frequency as the pulmonary hypertension increased.

The findings in the average subject with severe pul-
monary hypertension in association with mitral stenosis
may be summarized as follows: (1) a history of right
ventricular failure; (2) electrocardiographic evidence
of right ventricular hypertrophy in precordial lead V;
(3) roentgen demonstration of moderate or marked
right ventricular hypertrophy, with the transverse diam-
eter of the heart within normal limits, or slightly
above.

Five roentgenograms; 2 tables.

HENRY K. TAYLOR, M.D.
New York, N. Y.

**Use of Planigraphy in Demonstration of Calcifica-
tion of Heart Valves and Its Significance.** Louis A.
Sloff, Jacob Zatuchni, and Herbert Fisher. *Arch. Int.*
Med. 95: 219-223, February 1955.

This paper concerns the value of planigraphy in un-
covering unsuspected mitralvalvular cardiac lesions, in
the discovery of valve calcification in otherwise unex-
plained cardiomegaly, and in the preoperative evalua-
tion of patients for intracardiac valve surgery.

Calcification within a heart valve is an absolute and
irreversible manifestation of disease and is specific for
the valve involved. In the case of the mitral valve the
probability of an associated valve lesion is very high.

Planigraphic studies of the heart in 31 patients re-
vealed calcification of the mitral valve alone in 9, of the
mitral valve and left atrium in 3, of the mitral and
aortic valves in 9, and of the aortic valve alone in 5.
Multiple valve lesions were disclosed where none or
only one was suspected as a result of other methods of
investigation. Valve lesions were discovered in pa-
tients with cardiomegaly or precordial murmurs of un-
certain origin.

Calcification of the mitral valve usually produces
mitral stenosis and regurgitation. Each of the 9 patients
with mitral valve calcification who were operated upon
had a small mitral orifice. Eight of these had a regur-
gitant jet before operation and in 4 of these it was in-
creased by surgery. It thus appears that calcification
increases the risk of the production of more regurgita-
tion and of embolism by mitral commissurotomy.

Eight roentgenograms.

THEODORE E. KEATS, M.D.
University of California, S. F.

Pericardial Calcification and Histoplasmin Sensitivity. F. T. Billings, Jr., and O. A. Couch, Jr. *Ann. Int. Med.* 42: 654-658, March 1955.

Two cases are reported in which pericardial calcification was demonstrated on the roentgenogram and fluoroscopically in patients with negative tuberculin tests and positive skin tests for histoplasmin, suggesting that histoplasmosis may be another cause for calcium deposits in the pericardium.

Two roentgenograms.

Congenital Lutembacher Syndrome. A. de Carvalho Azevedo, M. Barreto Neto, A. Alves de Carvalho, A. Garcia, R. Roubach, and A. Ney Toledo. *Am. Heart J.* 49: 302-309, February 1955.

The authors give the history of an 18-month-old boy with a congenital mitral stenosis and interatrial septal defect. The diagnosis was based on cardiac murmur, angiocardigraphic findings, electrocardiograms, and results of cardiac catheterization. The roentgenogram showed an enlarged heart with a small vascular pedicle and slight bulging of the left middle segment. The cardiothoracic ratio was 0.60. The aorta was small and the lungs were congested, with increased vascular markings. The child expired during an attempt at commissurotomy. Postmortem examination revealed a persistent ostium primum, interatrial septal defect, mitral stenosis, and tricuspid anomaly.

Nine figures, including 1 roentgenogram; 1 table.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Persistent Left Superior Vena Cava. George Miller, Thomas W. Inmon, and Byron E. Pollock. *Am. Heart J.* 49: 267-274, February 1955.

The authors report 3 cases in which a left superior vena cava was diagnosed by cardiac catheterization, utilizing both right and left arms. The embryologic basis of the anomaly is briefly presented, and the most widely accepted theory explaining its occurrence is outlined.

If a persistent left superior vena cava drains into the right atrium, as it usually does, there is no additional strain upon the heart, and there is no admixture of venous and arterial blood. If an additional congenital cardiac anomaly is present, a left superior vena cava may obstruct the approach at time of surgery. In such a case, it is of importance to know whether a right superior vena cava is also present, whether there is any communication between the two, or whether such a communication could be constructed.

When anomalous pulmonary veins empty into a left superior cava, the condition is similar to anomalous pulmonary venous drainage directly into the right atrium. Depending upon the magnitude of the anomalous drainage, surgery may or may not be indicated. When it is indicated, knowledge of the presence of a right and left superior vena cava, with or without communication, is vital for the proper procedure.

Rarely, a left superior vena cava may drain into the left atrium, in which event there is the equivalent of a right-to-left shunt with an admixture of venous and arterial blood.

The diagnosis of persistent left superior vena cava cannot be made on clinical findings alone, but is readily made by angiocardiology performed by way of the left arm. The variables that may occur with a persistent left superior vena cava are: (1) presence or absence

of right superior vena cava; (2) presence or absence of a communication between the superior venae cavae; (3) character of anastomosis, i.e., single vessel or plexus; (4) location of drainage, into the right or left atrium; (5) presence or absence of cardiac anomalies.

Four roentgenograms; 3 schematic drawings; 1 table.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Anomalous Inferior Vena Cava with Azygous Drainage: So-called Absence of the Inferior Vena Cava. Ray C. Anderson, William Heilig, Rosalind Novick, and Charles Jarvis. *Am. Heart J.* 49: 318-322, February 1955.

The authors give the case history and autopsy findings for an infant with an anomalous inferior vena cava with azygous drainage. This anomaly has been described also as absence of the inferior vena cava, persistence of the supracardinal system, persistent posterior cardinal vein, persistent left inferior vena cava, and azygous continuation. Six cases were found in the literature.

The authors' patient was a boy of three months. Angiocardiography was carried out through the left saphenous vein. The contrast medium passed from the iliac vein into the azygous vein, which in turn emptied into the superior vena cava. The entire heart appeared to fill almost immediately, and the aorta and pulmonary arteries showed simultaneous filling. Because the findings were quite similar to those in a case described by Campbell and associates (*Brit. Heart J.* 14: 317, 1952. *Abst. in Radiology* 60: 762, 1953), the authors made a diagnosis of bilocular heart, pulmonary stenosis, patent ductus, and absence of the inferior vena cava. Prior to angiocardiology the diagnosis was "single ventricle with pulmonary stenosis." The patient was considered inoperable and returned home.

At the age of four and a half months the child was admitted to another hospital and died four days later. Autopsy revealed a roughly triangular heart composed of two chambers, a common atrium and common ventricle. Two auricular appendages were present. Two hepatic veins entered the most inferior portion of the right side of the atrium independently. The pulmonary veins entered the left side of the atrium. The atrium was dilated. There was a single atrioventricular valve, and the large common ventricle emptied into the aorta through a normal appearing aortic valve. No pulmonary valve was identified, and the pulmonary artery was represented by a narrow cord of connective tissue which extended from the heart to the ductus arteriosus. The right and left pulmonary arteries were normal in size, shape, and position, arising at a point where the remnant of the main pulmonary artery joined the ductus arteriosus. The root of the aorta was normal, and the great vessels of the neck arose normally from the aortic arch. The ductus arteriosus was large and patent. The hemiazygous vein was absent. The right and left intercostal vessels drained into an enlarged azygous vein, which emptied into the superior vena cava. The common iliac vein and the renal vein emptied into what was probably a persistent right post-cardinal vein, in that it was continuous with the azygous vein emptying into the superior vena cava. The diagnosis was congenital heart defect (cor biloculare with persistence of the right post-cardinal vein and absence of the hemiazygous vein).

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pecially by way of the leg veins, a larger number of reports of this anomaly of the inferior vena cava can be expected. Downing (Pediatrics 12:675, 1953. Abst. in Radiology 63: 597, 1954) suggested a diagnostic roentgen sign for the detection of this anomaly on plain films. "...a rounded density in the superior mediastinum which projects to the right at the position of the normal junction of the superior vena cava and right atrium. This shadow represents the dilated, anterior coursing azygos vein as it enters the right atrium or superior vena cava."

One roentgenogram; 1 table.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Anomalous Pulmonary Arteries. Saul F. Landry, Jr., and John S. Salatic. Arch. Surg. 70: 411-413, March 1955.

An unverified case of anomalous pulmonary arteries arising from the aorta supplying the lower lobes is presented, probably with an associated intralobar sequestration on the right. The authors make the point that at least in their case the vessels could be shown on the plain films and planigrams, coursing abnormally through the lungs (vertically instead of from the hilus). The patient refused surgery or further study, so that proof was not available.

Two roentgenograms. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Traumatic Aneurysm of the Right Lower Pulmonary Lobe: Sequel of a Shell Wound. Lobectomy. Cure. Cornet, Vittori, and Barrière. J. franç. méd. et chir. thorac. 9: 259-264, 1955. (In French)

A soldier suffered a traumatic wound in which a metallic missile entered the thorax near the scapula and remained behind the sternum. Routine postero-anterior and lateral films of the chest showed a round homogeneous density in the right lower lobe. Lobectomy revealed an arterial aneurysm without venous communication.

Three roentgenograms; 2 photographs.
CHARLES M. NICE, JR., M.D.
University of Minnesota

Transosseous Mediastinal Phlebography. G. Tori and L. Cavicchi. Bull. sc. med. 127: 1-19, January-March, 1955. (In Italian)

Adequate opacification of certain venous systems can be obtained by injecting contrast material into neighboring osseous structures. For instance, the mammary veins can be visualized by intrasternal injection, and the inferior vena cava (only partially under physiologic circumstances) by way of a lumbar spinous process.

The authors demonstrated the mediastinal veins, and particularly the azygos system, by injecting 15 to 20 c.c. of Urokon (70 per cent) in three or four seconds into the posterior segment of one of the right ribs (fifth to tenth). For the hemiazygos, or its accessory, the approach must be by way of the left ribs. The technical details are those employed in obtaining bone marrow samples by sternal puncture, though allergic and/or toxic reactions to the iodine compound have to be taken into consideration. The mediastinal veins can also be filled by injecting a spinous process (T-5 through T-10), but the procedure is technically more difficult.

Further series are needed to establish the value, indications, and contraindications of this method. The present paper is devoted mainly to "normal" phlebographic patterns of the mediastinum, but it includes also a case of obstruction of the azygos by metastatic seminoma of the right hilus, with opacification of the inferior vena cava following intracostal injection.

Seventeen roentgenograms, with schematic drawings.
E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

Percutaneous Splenoportography. Melvin M. Figley, William J. Fry, John E. Orebaugh, and H. Marvin Pollard. Gastroenterology 28: 153-162, February 1955.

The authors perform percutaneous splenoportography under local anesthesia, using a 3-inch 18-gauge needle. A slow drip of blood and wide movement of the needle butt with respiration indicate proper puncture, but test injection of 5 c.c. of dilute contrast material with prompt filming is advised as a check. Thereupon 25 c.c. of 70 per cent water-soluble organic iodide solution is rapidly injected and four or five films are obtained in rapid succession in the next twenty seconds.

The contrast material promptly leaves the pulp, entering the splenic vein and moving on to the portal vein and its intrahepatic branches. Terminally one obtains homogeneous opacity of the liver. The procedure is of value in diagnosis of portal hypertension, cirrhosis of the liver, extrahepatic portal obstruction, and non-vascular space-occupying lesions of the liver, such as neoplasms and cysts.

Moderate left upper quadrant pain is produced by injection, lasting for fifteen minutes. Intrapleural and intraperitoneal injection have occurred without tragedy. Others have inadvertently injected the medium into the stomach and colon without serious results. No damage to the spleen has been found in follow-up procedures. The principal hazard is splenic hemorrhage, but the incidence of this has been low (less than 1 in 100). Selection of patients for the procedure should, however, be limited to those who could tolerate splenectomy if this were required to control hemorrhage.

Failure of visualization can occur because of extra-splenic deposition or occlusion of the splenic vein.
Nineteen roentgenograms.

DONALD DE F. BAUER, M.D.
Coos Bay, Ore.

Further Experience with Percutaneous Lieno-Portal Venography. V. Gvozdanović and E. Hauptmann. Acta radiol. 43: 177-200, March 1955.

An earlier report by the authors on percutaneous lienoportography (Acta radiol. 40: 17, 1953. Abst. in Radiology 62: 788, 1954) was based on 14 cases. They have now used the procedure 61 times on 54 patients, injecting 20 c.c. of 70 per cent Jodurum into the spleen in two or three seconds. Manual changing of cassettes has been replaced recently by use of a rapid cassette changer, permitting exposure of four films per second.

All of the patients examined had splenomegaly and the examination was used not only where disease along the course of the lienal and portal veins was expected but in others as well to demonstrate the normal course of the vessels.

Side reactions were mild and transitory, consisting of a sensation of heat, nausea, and pain in the punc-

tured area. Complications occurred 18 times, consisting in spread of the medium backward along the puncture canal (10 times), injection into the peritoneal cavity, stomach, and colon (2 times each), and bleeding from the spleen (2 times).

In this series of 61 examinations, the width of the lial and portal veins was found to average 1.6 and 1.9 cm., respectively. Patients with cirrhosis usually showed an enlarged lumen; none showed a narrowing. The veins were seen to cross the vertebral column between T-12 and L-3 in every instance.

Of the 7 examinations in which the rapid cassette changer was employed, variation in the rate of blood flow was noted. A rather marked slowing of the circulation through the liver occurred in patients with cirrhosis. In addition, there was a reflux of the medium into the lial and portal tributaries when either cirrhosis or thrombosis of the splenic vein was present.

In all 6 cases of thrombosis and in 1 case of cirrhosis, a collateral circulation through newly formed blood vessels was clearly demarcated. Anomalies in the blood vessels in the lienoportal circulation were found in 3 patients.

The authors feel that this examination is reasonably safe and enables one to visualize the course and size of the lial and portal vessels and the circulation time. It is extremely helpful in (1) correcting a clinically postulated erroneous diagnosis of lienoportal thrombosis; (2) localizing an existing thrombosis and revealing the collateral circulation; (3) differentiating preoperatively an extrahepatic from an intrahepatic obstruction; (4) as an adjunct in diagnosis of anomalies of the lienoportal circulation. The opinion is expressed that the procedure is indicated in every case of portal hypertension of unknown origin.

Twenty-six roentgenograms; 2 tables.

JAMES BUICE, M.D.
University of Arkansas

Arteriographic Appearances of the Digital Arteries of the Hands in Raynaud's Disease. R. B. Lynn, R. E. Steiner, and F. A. K. Van Wyk. *Lancet* 1: 471-474, March 5, 1955.

The authors attribute controversy surrounding so-called Raynaud's disease to a misconception that the patients described by Raynaud formed a homologous group. In this study, an attempt was made to distinguish two groups among 23 patients with intermittent spasm of the digital arteries combined with color changes (associated with exposure to cold). Fourteen women and 9 men, between the ages of fifteen and sixty-five, were studied arteriographically to differentiate conditions involving obliteration of the digital arteries from those with anatomically normal arteries. It was thought that arterial obliteration contraindicated sympathectomy and that surgery could be excluded on the basis of arteriographic evidence.

The patients were anesthetized, a blood-pressure cuff was applied to the arm well above the elbow, and the hand was strapped to a wooden cassette tunnel. The cuff was inflated to above systolic blood pressure to arrest the arterial circulation in the hand; 15 ml. of 50 per cent diiodone was rapidly injected, and the first film was exposed. Circulation was then temporarily restored by lowering pressure in the cuff to diastolic level, the pressure was rapidly increased, and the second film was exposed. This was repeated until five films

of each hand were obtained, the entire procedure taking (for each hand) about fifteen seconds. No complications as a result of the process were noted.

Sixteen patients showed anatomically normal digital arteries, and in 7 there was evidence of obliteration, confirming that vascular spasm may develop both in hands where the digital arteries are structurally altered and in those in which they are anatomically normal. There was, moreover, almost complete correlation between the arteriographic findings and the nutritional state of the digits. Patients exhibiting paronychia ulceration or infection, pulp atrophy, rigid brittle fingernails, or phlyctenular gangrene were those in whom arterial obliteration was demonstrable by arteriography.

The findings presented here and elsewhere in the literature, it is believed, suggest that there are two different conditions presenting the same clinical symptoms but distinguishable arteriographically. It is proposed that the name "Raynaud's disease" be reserved for the group of patients (likely to respond to surgery) in whom no anatomical abnormality can be recognized arteriographically; for cases in which obliteration of digital arteries is demonstrated, the term "thrombotic digital-artery disease" is recommended.

Four roentgenograms; 3 photographs.

THE DIGESTIVE SYSTEM

Leiomyoma of the Esophagus. Luigi Piacentini. *J. Thoracic Surg.* 29: 296-316, March 1955.

The author reviews the literature on leiomyomas of the esophagus and reports 2 cases. These tumors are most frequently found in the lower third of the esophagus, originating from the muscle layers of the esophageal wall. Those found incidentally postmortem are usually single nodular lesions, whereas the clinical cases, producing symptoms, are usually multinodular.

Of 95 cases in the literature, 61 were asymptomatic. Early manifestations are rather vague painful sensations, which the patient finds difficult to describe. Dysphagia may be the only symptom, most frequently following the ingestion of solid foods. Pain associated with swallowing may be retrosternal, thoracic, epigastric, or even in the shoulder. It is usually crampy, with spontaneous remissions and exacerbations. Nausea, vomiting, and regurgitation sometimes occur.

The diagnosis is most readily made radiologically. Enucleation is the operation of choice for single node leiomyomas. Those tumors which are intimately associated with the mucosa may require esophageal or gastroesophageal resection.

Both of the author's cases involved the lower third of the esophagus. Both tumors were "U" shaped. In each instance excision was followed by recovery.

Nine roentgenograms; 8 photographs and photomicrographs; 1 table.

RENE FORTIER, M.D.
St. Paul, Minn.

Gastric Diverticula. E. Alan Price. *South African M. J.* 29: 153-157, Feb. 12, 1955.

Two cases of gastric diverticula are reported. The first was unusual for the association of a gastric volvulus, presumably due to the diverticulum. In the second, the site was an uncommon one, namely, the greater curvature near the upper pole of the fundus, at a level above the cardioesophageal opening.

It is pointed out that a gastric diverticulum may

easily be missed on radiological examination, as in the first two barium studies in Case I and the first three in Case II. It is suggested that, in all cases of unexplained symptoms referable to the upper gastrointestinal tract in which barium studies are negative, the possibility of a gastric diverticulum should be investigated. A slight modification of routine procedure is recommended: The patient should be examined in the supine and prone positions soon after the first few mouthfuls of barium have been swallowed; otherwise, a full fundus may obscure the diverticulum. Sufficient time should be permitted for the diverticulum to fill, because a narrow neck may be present. It is therefore advisable to re-examine the patient after he has been lying on his back for ten to fifteen minutes.

A brief review of the literature with reference to incidence, classification, site, etiology, and symptomatology is included.

Six roentgenograms; 2 drawings.

Effects of Two Commercial Emulsifiers, MYRJ 45 and MYRJ 52, on Gastric Acidity and Gastrointestinal Motility of Human Subjects. Wesley M. Oler and Virginia C. Craemer. *Gastroenterology* 28: 281-287, February 1955.

The authors studied the effects on gastric acidity and motility of two substances used commercially in the preparation of foods which are common in the American diet, such as ice cream, bread, and tapioca. The substances tested were non-ionic polyoxyethylene monostearate compounds. The motility studies were based on periodic roentgen observations on the progress of three test meals, one containing barium sulfate and water; the second, barium sulfate-water and MYRJ 45; the third, barium sulfate-water and MYRJ 52. The experiments showed that with ten times the maximum concentration of these emulsifiers used in foods there was no detectable influence on gastric acidity, gastric emptying, or mouth-to-cecum time.

Three graphs. DONALD DE F. BAUER, M.D.
Coos Bay, Ore.

Papillary Lymph Nodule Hyperplasia of the Duodenum (Report of a Case). Harry Golodner, Morris Slobodkin, and Charles M. Ripstein. *Surgery* 37: 409-414, March 1955.

Lymphoid hyperplasia of the rectum, appendix, colon, ileum, and stomach has been recorded, but apparently no report of duodenal involvement has appeared in the literature. The authors present a proved case of papillary lymph nodule hyperplasia of the first portion of the duodenum. The unique picture on x-ray examination, consisting of multiple "buckshot" filling defects in the duodenal bulb, makes it possible to differentiate this benign condition from other diseases of the duodenum.

Three roentgenograms; 2 photomicrographs; 1 photograph.

Radiologic Features of Perforations of Duodenal Ulcers into Extrahepatic Biliary Ducts. Vinci Grossi. *Arch. di radiol.* 29 (n.s. 3): 319-335, 1954. (In Italian)

Fistulous communications between the bile ducts and the gastrointestinal tract are due (in order of frequency) to cholelithiasis, duodenal ulcer, cholecystitis, peripapillary cancer (these four entities represent 98 per

cent of the total), gastric tumors, subhepatic inflammatory processes, sclerosis of the common duct, perforated diverticula. To these must be added the surgically produced cholecystoduodenostomy, cholecystogastrotomy, and choledochoduodenostomy. Fistulas caused by duodenal ulcer have been variously estimated as constituting between 6 and 30 per cent of the total.

The radiologic examination is of considerable importance, more so because of the non-specific symptomatology. The preparatory ("flat") film of the abdomen must be carefully searched for evidence of gas in the biliary ducts, regarded as a proof of abnormal communication with an air-containing viscus. Barium penetrates the bile ducts more easily than gas, provided the suspension is thin, the timing adequate (fifteen to twenty minutes after ingestion for large surgical stomas; thirty to forty-five minutes for filiform spontaneous communications), and various positions are utilized (prone, followed by right lateral decubitus; Trendelenburg; left lateral decubitus; supine for cholecystogastrotomy). The common duct is more often filled than the hepatic. In perforations of ulcer origin, minor angiocholitic changes are noted in the intrahepatic channels (when filled), as opposed to cholelithiasic fistulas, which are usually accompanied by dilatation of the common duct and sclerosis of the gallbladder.

To be differentiated are: (1) vascular markings of the right lung in the posterior sulcus, (2) intrahepatic vascular markings, (3) spontaneous visualization of the bile ducts due to opaque bile, (4) abnormal location of the second portion of the duodenum, (5) pedunculated duodenal diverticula, (6) infrahepatic abscess, (7) abnormal subdiaphragmatic (inter)position of the hepatic flexure, (8) the outline of the psoas muscle, and finally (9) reflux through the sphincter of Oddi, kept open by functional or organic changes. Age, sex, clinical history, site of the fistula, the presence of calculi, and the morphology of the biliary ducts are the differential points between a cholelithiasic and ulcer origin. The absence of a fistulous tract corresponding to the duodenal crater (niche), visualization of the terminal portion of the common duct, amount and rate of penetration of the contrast material into the biliary ducts help to distinguish reflux through a dilated sphincter of Oddi.

Mention is made of 5 personal cases (4 choledochoduodenal and 1 cholecystoduodenal) seen during six years. Of these, 4 were confirmed surgically.

Six roentgenograms. E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

Carcinoma of Jejunum in Intestinal Polyposis with Oral and Digital Melanosis. W. P. Kleitsch, R. J. Korn, and H. B. Saichek. *Arch. Surg.* 70: 393-397, March 1955.

The association of intestinal polyps with peculiar melanin deposits on the hands, feet, and around the mouth (Peutz-Jeghers syndrome) has been recognized for only a little more than five years. The pathognomonic feature is the occurrence of the pigmented spots on the mucous membrane of the lips or inside the mouth as well as on the skin. The polyps may be found anywhere in the intestinal tract and are usually numerous. They are notoriously precancerous.

A single case is reported, in which a malignant polyp in the jejunum caused recurring obstruction and a

severe anemia. A dozen or more benign polyps were found in various areas of the small bowel and colon. The small bowel polyps were not demonstrable, but those in the colon were apparent on the x-ray film.

Recognition of the characteristic pattern of pigmentation is a definite indication for gastrointestinal studies. Roentgenography is useful in demonstrating polyps in the stomach and colon, but laparotomy may be necessary to identify such lesions in the small bowel. The polyps should be removed and studied histologically for evidence of malignant change.

Two roentgenograms; 2 photomicrographs; 5 photographs.

ZAC F. ENDRESS, M.D.

Pontiac, Mich.

Roentgen Diagnosis of Small Polyps in the Colon and Rectum. Lars Andrén, Sture Frieberg, and Sölve Welin. *Acta radiol.* 43: 201-208, March 1955.

The importance of finding and removing polyps as a method of cancer prophylaxis is stressed. The technic used by the authors is as follows: The patient is prepared by administration of castor oil the day preceding examination, with a cleansing enema in the evening and again the following morning. On arrival in the x-ray department, he receives 15 mg. of extract of belladonna and another cleansing enema to which have been added Neodrast (dioxiphenylisatin) and tannic acid. For the contrast enema a fairly dense medium is used, and to this, also, Neodrast and tannic acid are added.

The contrast enema is not allowed to go beyond the transverse colon. When it has reached that point, postero-anterior, oblique, and profile views of the rectum, sigmoid colon, and splenic flexure are obtained.

After evacuation of the enema, which is checked by fluoroscopy, more contrast material is introduced to insure filling of the bowel as far as the middle of the sigmoid colon, and air is introduced. The contents of the rectum are drained off and double-contrast films are obtained in both oblique projections, with the patient prone and supine. A profile view of the rectum and sigmoid colon may be included. Views are then taken with a horizontal beam in both the right and left recumbent positions.

After the radiographs have been taken, the air is released through the enema tube, with the patient on his right side in the prone position. Very weak or seriously ill patients suspected of having recurrent appendicitis offer the only exception to this procedure. Such patients are examined by the routine contrast method, without air.

Between Dec. 1, 1953, and Aug. 15, 1954, 1,274 patients were examined. Of this number, 159 were found to have one or more polyps. Of the polyps demonstrated roentgenographically, 66 were confirmed either by surgical intervention or by proctoscopy. Most of the others were verified by repeated examination.

The position of the polyps was as follows: 46 per cent in the rectum; 21 per cent in the sigmoid colon; 13.6 per cent in the descending colon; 13.6 per cent in the transverse colon; 5.4 per cent in the ascending colon and cecum.

Proctoscopic examination revealed only a single case which was not previously diagnosed roentgenologically. Ninety per cent of the polyps demonstrated were less than 1 cm. in diameter.

Seven roentgenograms; 3 tables.

WALTER L. SIMS, M.D.
University of Arkansas

The So-Called Shelf Tumour of the Rectum. K. A. Hultborn, O. Morales, and R. Romanus. *Acta radiol.* Supplement 124, 1955.

"An extra-rectal mass in the recto-genital pouch (Douglas' pouch) or in the recto-genital septum has, ever since Blumer's description in 1909, frequently been called a tumour in Blumer's shelf or shelf tumour. The term embraces all lesions which jut into the anterior wall of the rectum in the form of a shelf or ridge. These shelf tumours are of both diagnostic and therapeutic interest, especially as they may be mistaken for primary rectal carcinoma."

Following the above introduction, the authors give an excellent anatomic description of the caudal portion of the peritoneal cavity, pointing out the feasibility of maintaining a filled bladder during enema and sigmoidoscopic study, thereby elongating the rectum and displacing the sigmoid portion of the colon upward so that it may be freely palpated and examined.

Multiple pathologic processes from infection to neoplastic disease and the resultant disturbances and changes within the rectogenital pouch are described. Nine cases are reported which illustrate different diagnostic aspects, especially the value of the roentgen examination. These cases, which include rectal endometriosis, metastases from carcinoma of the colon and of the pancreas, and changes incident to proctitis, demonstrate the significance of a correct diagnosis preoperatively, in particular the importance of ruling out a primary cancer and avoiding radical surgery.

The authors' concluding sentence reads: "In view of the occurrence of shelf tumours, all rectal tumours in this region should be subjected to a complete proctologic examination, including palpation, sigmoidoscopy, and a contrast enema, as well as biopsy, before any therapy is initiated."

Twenty-seven roentgenograms; 3 photographs.

JOSEPH P. TOMSULA, M.D.
Baton Rouge, La.

Cholangiography: A Critical Analysis. Herbert G. Kantor, John A. Evans, and Frank Glenn. *Arch. Surg.* 70: 237-252, February 1955.

This paper is based on a series of 158 cases in which 171 operative and 234 postoperative cholangiograms were obtained. Cholangiography was done at the discretion of the surgeon and there was no standard method of performing the examination. In 42 cases no biliary duct lesion was found surgically. The abnormalities found in the remaining 116 cases are presented in tabular form. The lesion was demonstrated by cholangiography in 55 cases, but precholedochotomy cholangiograms were not obtained in all instances.

There is a brief discussion of the normal cholangiogram with a summary of measurements of the extrahepatic biliary system. Calculus of the common bile duct is by far the most frequent abnormality found. In this series it accounted for 40 of the 55 cases in which the lesion was demonstrated cholangiographically. Tumors were demonstrated in 8 cases, strictures in 6 cases, and a choledochal cyst in 1 case. The roentgenographic differentiation of these lesions and the etiology of spasm of the sphincter of Oddi are discussed. The latter was found most frequently in operative cholangiograms. Air bubbles were more frequently a problem in postoperative cholangiography, and usually could not be distinguished from stones.

The authors feel that cholangiography is an impor-

tant tool in the diagnosis of lesions of the biliary tract, but that its effectiveness is dependent on the care with which the examination is done. In this series 48 per cent of the operative and 34.2 per cent of the postoperative cholangiograms were considered unsatisfactory because the entire tract was not visualized with the demonstration of defects adequately explained pathologically. It is felt that, with careful examination and full cooperation of surgeon, radiologist, and anesthesiologist, over 90 per cent of cholangiograms should be satisfactory. A detailed summary of the recommended technique is included and should be read in the original.

Twenty-two roentgenograms; 3 tracings; 7 tables.

D. PETERSON, M.D.
Indiana University

The Normal and Abnormal Biliary Tract as Shown by Intravenous Cholecystography and Cholangiography. J. Edward Berk, Herbert M. Stauffer, Harry Shay, and Robert E. Karnofsky. *Gastroenterology* 28: 230-243, February 1955.

The data presented here extend and confirm the authors' previous observations on the use of Cholografin as a medium for cholecystography and cholangiography (*Am. J. M. Sc.* 227: 361, 1954. *Abst. in Radiology* 64: 299, 1955). This new medium permits rapid (three hours) examination of the gallbladder and bile ducts and provides a non-surgical method of cholangiography in cholecystectomized patients.

Thirty-five intravenous Cholografin studies were done on 31 subjects with intact gallbladders and 54 in 48 cholecystectomized patients. The gallbladder was visualized in 26 of the first group and the bile ducts in a like number. In the cholecystectomized series the ducts were demonstrated in 44. In 67 of the 70 successful ductal visualizations, some portion of the ductal system was apparent within thirty minutes after injection of the medium; maximum density was obtained in thirty to forty minutes. Two to three hours was required for maximum opacity of the gallbladder.

The bile ducts were successfully visualized after Cholografin by vein and after Telepaque by mouth in 11 of the 20 subjects studied by both methods. The density obtained with Cholografin was greater than with Telepaque in 10 of these 11 cases. In 1 subject the density of the ductal shadows after Telepaque closely approached that after Cholografin. In the remaining 9 patients the ducts were seen with Cholografin but not with Telepaque.

Reactions to Cholografin were insignificant. No evidence of local irritation at the site of injection was found even in cases with extravasation.

The importance of functional integrity of the liver for satisfactory results is again stressed, and the difficulty of adequate demonstration of the terminal segment of the common duct is mentioned. The authors give a fat meal and nitrites to relax the choledochal sphincter, with subsequent use of a smooth muscle constrictor, such as morphine, which improves concentration of the medium in the ducts by increasing the sphincter tone.

Eleven roentgenograms; 3 figures; 1 table.

DONALD DEF. BAUER, M.D.
Coos Bay, Ore.

Oral Cholangiography and the Pancreas in Radiology. A. Hudak. *Radiol. clin.* 24: 113-118, March 1955. (In French)

Visualization of the common duct after the oral

administration of the newer tri-iodated products is improved if papaverine is given some twenty to thirty minutes before the roentgenograms are obtained.

Study of the common duct is important not only for the biliary system itself, but even more so for the pancreas. There is a present tendency to underestimate the classic radiologic examination of the pancreas in favor of the newer methods, such as splenoportography, ductopancreatography, and axial stratigraphy. These newer methods are just as susceptible to criticism as the classic procedure, which must frequently be supplemented by contrast study of the stomach and duodenum, especially in the Trendelenburg position, with air rising to the antrum, by oral and intravenous cholangiography, and urography.

Three roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

RETROPERITONEAL TUMORS

Abdominal Aortography. John F. Berry, John J. Robbins, and Everett L. Pirkey. *Arch. Surg.* 70: 173-177, February 1955.

The authors present a short review of the value of abdominal aortography in the differential diagnosis of retroperitoneal masses. The technique used is similar to that described by Smith, Rush, and Evans (*J.A.M.A.* 148: 255, 1952. *Abst. in Radiology* 60: 627, 1953). Cases of abdominal aortic aneurysm, pheochromocytoma, and hepatoma are presented as representative of extrarenal retroperitoneal masses. Cases of renal tumors are also included. Papillary carcinomas and cysts present a similar picture: displacement of the renal vessels without evidence of increased vascularity. Renal-cell carcinoma typically shows laking, or pooling, of the opaque material, together with irregularly dilated sinusoids. The accompanying illustrations are the most valuable feature of the article.

Nine roentgenograms. D. E. WHEELER, M.D.
Indiana University

Roentgen Examination in Retroperitoneal Tumors of Children. Harold Fulton and W. A. Evans, Jr. *Arch. Surg.* 70: 178-190, February 1955.

The problem of roentgen diagnosis of retroperitoneal tumors in infants is simplified by the fact that these tumors are, almost exclusively, of three types: (1) renal embryoma (Wilms' tumor), (2) neuroblastoma, and (3) unattached embryoma (teratoma). Retroperitoneal rhabdomyosarcoma and lymphoma occur in children rarely, but the numerous other tumor types encountered in adults are virtually unknown.

The authors' analysis of the roentgen findings in 53 cases proved pathologically suggests a general nonspecificity of the various manifestations in differentiation, with the possible exception of the preponderance of skeletal metastases in neuroblastomas. When, however, the roentgenologic features are collectively considered and carefully correlated with the clinical criteria, these tumors may not only be separated readily from the non-neoplastic lesions, but accurately differentiated from one another in a high percentage of cases. The clinical and roentgen features of each, which may aid in their recognition, are listed as follows:

Wilms' Tumor

1. Age about three years
2. Abdominal mass
3. Hematuria in some instances
4. Fever in one-half of cases
5. Hypertension in many cases
6. Mass visualized on plain abdominal roentgenogram
7. Calcification within tumor infrequent (when present it is of linear, peripheral type)
8. Normal renal contour never present
9. Kidney displaced in any direction
10. Non-function of involved kidney in one-third of cases
11. Pelvis and calyces almost always distorted; pattern "bizarre"
12. Metastasis to lungs and pleura; rarely to bone

Neuroblastoma

1. Age usually between one and two years
2. Abdominal mass
3. Hematuria absent
4. Fever infrequent
5. Hypertension unrelated
6. Mass visualized on plain abdominal roentgenogram
7. Calcification in one-half of cases (flocculent, central deposits most common type)
8. Normal renal contour in one-half of cases
9. Kidney displaced in any direction (medial and cranial displacement rare)
10. Non-function of kidney on involved side rare
11. Possible distortion of pelvis and calyces. Configuration may be indistinguishable from that of renal tumor; in many cases no pyelocalyceal disturbance
12. Metastasis to long bones, skull, pelvis, and meninges; lung metastases rare

Retroperitoneal Teratoma

1. Patients under one year of age
2. Abdominal mass (may be in mid-line of upper abdomen)
3. Hematuria absent; bleeding from the gastrointestinal tract possible
4. Fever infrequent
5. Hypertension unrelated
6. Mass visible on plain abdominal roentgenogram
7. Bone or tooth inclusion in mass characteristic
8. Normal renal contour
9. Kidney displaced in any direction; lateral displacement of both kidneys common
10. Non-function of kidney rare
11. In most cases no pyelocalyceal distortion
12. Metastasis rare

Eighteen roentgenograms; 2 drawings; 5 tables.

J. A. CAMPBELL, M.D.
Indiana University

Extraperitoneal Pneumography in Diagnosis of Retroperitoneal Tumors. Howard L. Steinbach and Donald R. Smith. *Arch. Surg.* 70: 161-172, February 1955.

The authors briefly review the history and technic of extraperitoneal pneumography. They prefer the use of oxygen introduced by the presacral route.

The procedure is probably most useful in examina-

tion of the adrenal glands. The relationship of the adrenals, kidneys, and "Gerota's fascia," which encloses these organs, is discussed, and the importance of the latter in differentiating tumors of adrenal or renal origin from lesions of adjacent organs is emphasized. Planigraphy sometimes has to be used to demonstrate the thin fascial membrane.

In an effort to evaluate the normal variations in size of the adrenal glands, the authors used a compensating polarimeter to determine the area of the gland as seen in the anteroposterior view. In adults, the average cross-sectional area of the right adrenal was found to be 4.2 sq. cm., with a range from 2.0 to 7.8 sq. cm. The average area of the left adrenal was 4.3 sq. cm., with values ranging from 2.0 to 8.7 sq. cm.

In 8 of 10 patients with adrenal cortical hyperplasia, the cross-sectional area of both adrenals was larger than any in the normal group. In 2 of the cases, visualization of both glands was not complete. The glands retained their normal contour, and the bilateral enlargement aided in differentiation from cortical adenoma. In 4 cases of cortical adenoma, the affected gland was more spherical in outline, and the opposite gland was atrophic. Pheochromocytomas cannot be differentiated from adenomas or encapsulated carcinomas. Very small adrenals may be seen in the presence of secretory tumors of the gonads.

Extraperitoneal pneumography is sometimes of assistance in the study of renal neoplasms. If the tumor is large enough to project beyond the cortex of the kidney, it is usually sharply demarcated, but cannot be differentiated from a cyst. Invasion by tumor, inflammation, and scarring secondary to earlier inflammation may cause absence of gas around the kidney.

Other retroperitoneal tumors, such as enlarged periaortic nodes, are demonstrated by pneumography only if they are large enough to extend beyond the psoas shadows. Tumors of the tail of the pancreas can sometimes be visualized. They are differentiated from lesions of the adrenal and kidney by observing the relation of the mass to Gerota's fascia.

By the questionnaire method, data were collected on 1,995 cases in which retroperitoneal pneumography was done, representing 17 institutions. No deaths or serious complications were recorded in this group. There are brief accounts of 4 severe reactions in cases from other sources, 2 of which terminated fatally. In both of these room air was used as the contrast medium.

Twenty roentgenograms. D. PETERSON, M.D.
Indiana University

Combined Use of Contrast Media in Retroperitoneal Tumors. Critical Evaluation. Arthur T. Evans. *Arch. Surg.* 70: 191-198, February 1955.

The procedures utilized in the diagnosis of retroperitoneal tumors are listed (pyelography, pneumography, arteriography), and their use singly and in combination is discussed. Because of the risk involved, it is felt by the author that, with few exceptions, little is gained by subjecting the patient to more than one procedure simultaneously. Furthermore, the combined contrast media often result in confusing or uninterpretable radiographs.

Various combinations of pyelography, pneumography, and aortography have been tried. Retrograde pyelography and aortography were combined in the study of renal parenchymal tumors, with dilute contrast medium for the retrograde study to prevent arterial

obliteration. Despite the pleasing radiographs so obtained, it is felt that the procedure offered no more, diagnostically, than did the examinations done singly. Twelve roentgenograms. C. H. HELMEN, M.D. Indiana University

HERNIA

The Roentgen Appearance of Abdominal Hernias. Peter Stucki-von Muralt. Radiol. clin., Supplement to Vol. 24, 1955.

The material upon which this monograph is based consists of 30 inguinal and femoral hernias, 10 epigastric and umbilical hernias, and 7 hiatus hernias, all of which were observed in one year in the Roentgen Diagnostic Central Institute of the University of Zurich. For statistical purposes, 70 more case histories of femoral hernia, 103 of epigastric, and 32 of hiatus hernia were gathered from the literature and reviewed and evaluated. No internal, incarcerated, or Littre type hernias were encountered.

The roentgen approach was found to be valuable in differentiating indirect from direct inguinal hernias. A small direct inguinal hernia can be visualized only in an oblique view, while those of larger size are seen in the anteroposterior view passing vertically downward over the pubic bone, resembling a femoral hernia. The differentiation between the two latter types can be made by marking the inguinal fold with wire and observing whether the hernia emerges above or below the marker. Of all cases of femoral hernia operated upon at the University Hospital in Zurich between 1949 and 1952, 17 per cent were misdiagnosed as inguinal hernia, a mistake which could have been avoided by roentgen study.

Roentgen examination with barium can evaluate the content of umbilical hernias as well as of ventral hernias. In the clinically less evident and diagnostically more difficult obturator, lumbar (through Petit's triangle), and sciatic hernias, the roentgen method is of great value. In hernias of the Littre type, only the intestinal wall opposite the mesentery is caught in the hernial opening, presenting signs of ileus. Laurell recommends giving only spoonfuls of thin barium suspension under these circumstances. Herniation of the urinary bladder occurs in inguinal and femoral hernias. If suspected, this should be studied by cystography.

A review of the literature revealed five types of internal hernia: (1) Hernia into the lesser sac. Here the lateral view, revealing the small bowel behind the gastric plane, is especially valuable. (2) Paraduodenal hernias in which the duodenum has an atypical course. In this type small bowel loops involved in the hernia are crowded together, suggesting that they have entered a pocket which in lateral view is seen behind the gastric plane. (3) Hernia into the intersigmoid recess, of which only 1 case has been described roentgenologically. On the plain film of the abdomen a distended small bowel loop is seen in the left pelvis, projected over other small bowel loops and partially obstructing the sigmoid colon. (4) Paracecal hernia. This can occur, according to Haxton (Brit. M. J. 2: 792, 1944) into four fossae, of which the superior and inferior ileocecal recesses are the two most important. (5) Hernia through the mesentery.

In discussing diaphragmatic hernias, the author reviews the anatomy and embryology of the diaphragm and the anatomy of the esophagogastric junction. He

gives also the Harrington (after Kirklin) classification into atraumatic and traumatic, with further subdivision of the atraumatic into congenital and acquired. Ten per cent of the hiatus hernias in the author's series were of the short esophagus type, 25 per cent were paraesophageal, and 65 per cent were sliding hernias.

The method of choice in demonstrating hiatus hernias is filling the hernia from below with the patient in the Trendelenburg position and rolling him in all directions in order to ascertain that the herniated portion of the stomach is above the diaphragm. Esophageal diverticula located immediately above the diaphragm can present difficulty in differentiation, but they fill before the stomach when barium is swallowed and cannot be filled from below. Phrenic ampulla will also fail to fill from below.

Sixty figures, including 21 roentgenograms. ALEXANDER R. MARGULIS, M.D. University of Minnesota

A Review of 70 Cases of Hiatal Hernia, with Particular Reference to Symptomatology. George V. Hall and Noel C. Newton. M. J. Australia 1: 449-454, March 26, 1955.

The authors introduce this paper on hiatal hernia with a discussion of the anatomy and pathological physiology of the esophageal hiatus in relation to the development of hernias of the short esophagus and paraesophageal types. Their material consists of 70 consecutive cases encountered in two years, 19 in males and 51 in females, with an age range of twenty-six to eighty-two years. Surgery was considered necessary in 23 of these patients, and it was believed that it might become necessary in others.

The authors classify their cases according to several syndromes with some overlapping: (1) pain simulating that of cardiac origin, 15 cases; (2) a history suggestive of cholecystitis or post-cholecystectomy syndrome, 9 cases; (3) a classical history of hiatal hernia with regurgitation and esophagitis, 28 cases; (4) esophageal obstruction, 12 cases; (5) anemia with or without hematemesis and/or melena, 10 cases.

The reported incidence of hiatal hernia in patients complaining of abdominal symptoms varies from 2 per cent to 10 per cent. The usual symptom is pain, most commonly in the gastric or substernal area, but sometimes occurring in the left or right upper quadrant of the abdomen or in the chest. The pain is often preceded by mild epigastric discomfort, frequently accompanied by eructation, which may afford relief. With esophagitis the pain becomes burning in nature and may radiate through to the back, rising into the neck, and even into the jaw, ear, or palate. It may also radiate into the shoulders and arms, particularly the left. It is often relieved by alkalies or simply by drinking water. The authors stress the importance of a differential diagnosis from true cardiac pain. They believe that many patients have been made "cardiac cripples" unnecessarily because of incomplete studies.

In addition to pain, patients may complain of flatulence, upper abdominal distention, dysphagia, regurgitation of fluid into the mouth, and heartburn. They may first consult a physician because of hematemesis or melena. The bleeding may be severe and profuse. Anemia may be the main presenting symptom, although a complete history will usually reveal other complaints.

The final diagnosis rests with the radiologist, who

may demonstrate an actual hernia or esophageal reflux. The patient should be examined in many positions—for example, supine with pressure in the epigastrium and with efforts at straining. The Johnstone maneuver with the patient bending over to touch his toes is also valuable.

Failure to demonstrate a hernia radiographically does not rule out the diagnosis, and esophagoscopy may be desirable both for initial diagnostic study and for evaluation of complications. It may be the only means of demonstrating esophagitis.

The prognosis of hiatus hernia is reasonably good with adequate medical treatment when esophagitis is absent and when there is no obstruction. In the presence of esophagitis surgically untreated, hiatus hernia is most likely to proceed to stricture formation. Indications for surgical correction of the hernia are as follows: (1) severe symptoms, even without esophagitis; (2) esophagitis; (3) anemia; (4) hematemesis and/or melena; (5) the presence of stricture formation.

Six roentgenograms; 7 diagrammatic drawings.

JOHN P. FOTOFULOS, M.D.
Hartford, Conn.

THE MUSCULOSKELETAL SYSTEM

Chondroectodermal Dysplasia. Report of a Case and Review of the Literature. Howard Weiss and Alexander D. Crosett, Jr. *J. Pediat.* 46: 268-275, March 1955.

What is believed to be the sixth complete case of chondroectodermal dysplasia in the literature is reported. [Another case, also reported as the sixth, was published in *RADIOLOGY* after the appearance of this paper (Chauss: *Radiology* 65: 213, 1955).—Ed.] The syndrome was first described by Ellis and van Creveld in 1940 and is characterized by the tetrad of chondrodysplasia, ectodermal dysplasia, polydactyly, and congenital heart malformation. The ectodermal dysplasia usually includes tiny deformed fingernails, malformed teeth, and sometimes fine scanty hair. In addition to these features, the patient here reported had an epispadias.

As in previously recorded cases, the chondrodysplasia with resultant dwarfism was manifest by relative and absolute shortening of the extremities with thickening and progressive distalward shortening of the tubular bones, the fibula being most shortened of all. Dysplasia and hypoplasia of the acetabula were also evident. The polydactyly was accompanied by syndactyly and synmetacarpalism. The congenital heart malformation was believed to be an interventricular septal defect.

The prognosis appears to depend on the severity of the malformations, particularly of the heart. Among the reported cases, no mortality has been recorded. At nine months of age, after several upper respiratory tract infections and episodes suggesting hepatitis, the authors' patient was doing well, was alert, and apparently of normal intelligence.

Seven roentgenograms; 1 photograph.

H. G. PETERSON, JR., M.D.
New Britain, Conn.

Osteomyelitis in the Newborn and Infant up to Two Months of Age. J. Marcelino Figueroa C. and Mario Silva Aguilar. *Rev. mex. de radiol.* 9: 30-41, March-April 1955. (In Spanish)

The authors discuss 24 cases of osteomyelitis, repre-

sented an incidence of 2.06 per 10,000 infants two months of age and younger; detailed data are given for 13 cases. There was absence of spontaneous motion of the affected limb in 11 patients, local swelling occurred in 10, abscess formation in 8, fever in 7, and regional adenitis in 3. A hematogenous origin was substantiated in most instances. Previous infection had been present 5 times each in the skin and the respiratory passages and twice in the gastrointestinal tract. Obstetrical trauma was incriminated twice, while 4 infants had a completely negative history. Two fatalities occurred (among the 13), but in each instance the cause of death (bronchopneumonia; diarrhea) seemed unrelated to the bone process.

Except for an unusual case of osteomyelitis of the mandible with exclusively osteolytic lesions, radiographic examination always revealed soft-tissue involvement, periostitis, and osteochondritis, the typical x-ray aspect appearing from five days to one month after the clinical onset. Emphasis is placed on the monotopic and (relatively) monostotic character, though in 9 (of the 13) the adjacent joint was also involved. The femur was the most frequent site. The only condition mentioned requiring differentiation is syphilis, which tends to be bilateral, symmetrical, and generalized.

Antibiotics were given in all cases, but in 8 (of the 13) surgical drainage was also performed. Sequels included shortening of the bone in 4 cases, widening in 2, and sclerosis in 1. Healed syphilis, on the contrary, leaves no residuals.

Ten roentgenograms. E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

Bone Infarct. Clinico-Radiologic Contribution. Aldo Angei and Raimondo Cossu. *Arch. di radiol.* 29 (n.s. 3): 20-30, 1954. (In Italian)

Infarction of bone results from local interruption of blood supply with necrosis of the bone marrow, which may or may not extend to the endosteum.

The *bone infarcts of caisson disease*, caused by gaseous emboli, are found most often in the femoral and humeral heads. On the roentgenograms there are circumscribed, sometimes confluent, areas of decreased density. If extensive, the necrosis may lead to flattening of the humeral or femoral head, with obliteration of the joint space and formation of osteophytes and joint mice, even though the integrity of the cortex has been preserved. In spongy bone, the areolar lesions are later replaced by fibrous tissue (encapsulation) and/or new bone (calcification).

The favored location of *primary bone infarcts* (fat embolism from non-skeletal trauma; embolism due to specific or non-specific arteritis, arteriosclerosis and/or hypertension, endarteritis obliterans, or other causes) is in the metaphyseal and epiphyseal regions of long bones. The diaphysis is seldom affected, because of the heavily anastomosed blood supply. In the beginning, a primary infarct may not be detectable roentgenographically; in the late stage, its aspect varies with the amount and distribution of calcium deposits.

By contrast, *secondary bone infarcts* (following intrinsic bone lesions) are located next to the disease process. The radiographic appearance is not characteristic.

In the differential diagnosis of bone infarct roentgenographically, one must consider calcified enchondroma, osteopoikilosis, osteoid osteoma, Brodie's abscess, melorheostosis, calcified intraosseous para-

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sites, chronic central osteomyelitis, osteogenic sarcoma, osteoblastic metastases, bone islands, pagetoid dysplasia, etc.

The condition is unquestionably rare, since the authors had to screen 30,000 roentgenograms to find the 6 cases which they report (3 in cardiac patients, 2 in divers, 1 of unknown cause). Three of the cases were confirmed by biopsy.

While surgical removal of the infarct has previously been advocated, in one of the authors' patients local roentgen therapy (3,000 r) brought about relief of pain. Ten roentgenograms. E. R. N. GRIGG, M.D.

Cook County Hospital, Chicago

Osteogenic Sarcoma Arising in Polyostotic Fibrous Dysplasia. Report of a Case. Neil G. Perkinson and Norman L. Higinbotham. *Cancer* 8: 396-402, March-April 1955.

The authors report a proved case of polyostotic fibrous dysplasia in which osteogenic sarcoma arose practically simultaneously from two distinct sites. The patient was a young man with an earlier diagnosis of Paget's disease. Skull films showed marked thickening of the calvarium with pagetoid changes and irregular cyst-like areas and narrowing of the cranial foramina. There were also right femoral bowing and coxa vara, with marked widening of the shaft. Changes similar to those in the skull were observed to involve the right half of the sacrum and pelvis, the right tibia and fibula, and the sixth rib.

Pain about the right hip was treated at various times by roentgen irradiation. A later pathological fracture in the same hip was treated with a bone graft. Fifteen years after the original diagnosis of Paget's disease, a skeletal survey revealed obvious roentgen evidence of osteogenic sarcoma in the upper third of the right femur. Biopsy confirmed this diagnosis and, on amputation, osteogenic sarcoma was found also in the tibia. The patient died with local recurrence at the amputation site and lung metastases. The authors believe that irradiation played no role in production of the malignant lesion in this case.

Six roentgenograms; 3 photographs; 3 photomicrographs. DON E. MATTHIEN, M.D.
Phoenix, Ariz.

Myelographic Procedures. Results and Risks. K. Reinhardt and K. Panter. *J. radiol. et d'électrol.* 36: 159-170, 1955. (In French)

The indications for myelography differ fundamentally when one is attempting to diagnose herniated disks as compared to the search for spinal tumors. In the presence of a tumor the disadvantages and risks may be accepted more easily than in the case of a herniated disk, which does not endanger life.

Classic myelography is justified in tumors producing complete block. With an incomplete block, less viscous contrast agents (Discolipidol or Pantopaque) are preferred. For the diagnosis of herniated disks Discolipidol may be used if water-soluble substances such as Methiodal (Abrodil) cannot be employed, and especially if a herniation is suspected above the first lumbar level. Any of the iodized oils may lead to arachnoiditis.

The indication for gaseous myelography is limited to complete tumor block and to the search for herniated disks in weakened patients. Peridurography is useful

in demonstrating herniated disks, but the results are less striking and the risk of irritation is great. Nucleography may be useful in some cases to study the disks directly, but there is always the danger of damaging a healthy disk.

Water-soluble Methiodal (Umbradil, iodopyracet, U.S.P.) is preferred in most cases of lumbar disk herniations and in tumors of the cauda equina. It is not applicable in the dorsal and cervical regions.

Twenty-six roentgenograms.

CHARLES M. NICE, JR., M.D.
University of Minnesota

Clinical Significance of the Transitional Lumbosacral Vertebra. Relationship to Back Pain, Disk Disease, and Sciatica. Frank E. Stinchfield and William A. Sinton. *J.A.M.A.* 157: 1107-1109, March 26, 1955.

Sciatic pain, although caused principally by intervertebral disk herniation, can also be produced by mechanical factors in the low lumbar region. In this article the relationships between sciatic pain, disk disease, and transitional lumbosacral vertebrae are analyzed. One hundred cases of transitional vertebra in which lumbosacral fusions were done are reviewed.

Sacralization of L-5 or lumbization of S-1 was more commonly bilateral than unilateral, but there appeared to be no constant relationship between this and the presence of motion of the joint. Preoperative roentgenograms permitted only about 50 per cent accuracy in predicting mobility of the transitional vertebra.

All 100 patients had back pain, usually of the recurrent lumbosacral type, with radiation into one or both sacroiliac regions and frequently into the buttocks or thigh of one side. In this series, 58 patients had true sciatic radiation of pain, which in 7 was bilateral. The sciatic radiation of pain in unilateral sacralization of L-5 usually occurred on the side opposite sacralization. All patients had narrowing of the lumbosacral interspace. Of 46 laminectomies and explorations, 31 showed herniated nucleus pulposus.

The 15 patients who were found not to have disk lesions gave histories of low back pain which began insidiously, with sciatic radiation from the very onset. In disk herniation, the pain is usually localized to the back originally, with sciatic radiation later. Also, there is usually history of at least minimal trauma.

In the light of their experiences, the authors feel that any of the following may plausibly explain the sciatica in the cases without disk herniation: (1) muscle spasm as a result of instability of a joint, producing pressure on the sciatic nerve; (2) venous engorgement through chronic irritation due to instability, causing pressure on the nerve root; (3) a recurring bulging (not herniation) undiscovered at time of surgery; (4) a disk that protrudes mechanically when the body is erect and is spontaneously reduced in the prone position.

In some cases, the vertebra above the transitional segment must assume the real function of motion of the lumbosacral joint, and thus needs to be included when fusion is performed.

Two roentgenograms; 1 table.

DON E. MATTHIEN, M.D.
Phoenix, Arizona

Osteochondritis Dissecans in the Navicular Bone of the Wrist. A. Ravelli. *Radiol. clin.* 24: 97-100, March 1955. (In German)

The usually encountered post-traumatic aseptic

necrosis of the navicular bone involves the proximal fragment because of its pattern of circulation. Only rarely are both fragments involved in the process. A spontaneous aseptic necrosis of the whole bone, as in the lunate, has not yet been reported.

Partial necrosis, osteochondritis dissecans, of the navicular occurs rarely. A case is reported in a forty-year-old man with a history of a fall eighteen months previously, followed by practically continuous disability. The roentgenogram demonstrated in the proximal ulnar edge of the navicular bone a small defect with thickening of its base and with several very small, dense bony shadows lying within it. This picture is to be differentiated from a small avulsion fracture, an example of which is presented.

Three roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

THE SPINAL CORD

Spinal Extradural Cysts. Report of a Case. Henry M. Cuneo. *J. Neurosurg.* 12: 176-180, March 1955.

Extradural cysts of the spinal cord occur usually in the lower mid-thoracic region of adolescents. The cysts cause little if any pain. Weakness of the lower extremities is characteristic and may progress to a spastic paraplegia. Loss of sensation is never severe. Kyphosis may be present.

The cysts produce widening of the spinal canal in either diameter, and frequently erosion of the pedicles at the cyst level. They are primarily filled with cerebrospinal fluid and are considered to represent diverticula of the spinal meninges. Communication with the subarachnoid space has been demonstrated at surgery or, as in the case reported by the author, by filling of the cyst with Pantopaque during myelography.

Three roentgenograms.

ARTHUR S. TUCKER, M.D.
Cleveland Clinic

GYNECOLOGY AND OBSTETRICS

Diagnosis and Prognosis of Female Genital Tuberculosis. Bruce P. Zummo, Harry Sered, and Frederick H. Falls. *Am. J. Obst. & Gynec.* 70: 34-42, July 1955.

That genital tuberculosis may masquerade as some other gynecological lesion is attested by the fact that the diagnosis was missed preoperatively in 30 per cent of 64 cases reviewed. Intestinal obstruction, pelvic inflammatory disease, and appendicitis were frequent diagnoses. In this series, 25 patients had evidence of lung involvement, but only 5 of these gave a history of pulmonary disease one or more years preceding admission. Ten patients had abnormal gastrointestinal roentgen studies, 7 of which were suggestive of tuberculosis. Eight patients had hysterosalpingograms with an unstated number showing non-specific findings of tortuous oviducts, either patent or occluded. This examination is suggested in all suspected cases unless acute salpingitis is present but is considered unreliable for tuberculous endometritis.

The final diagnosis is based on laboratory and biological studies and histologic biopsies. The more recent addition of PAS and INH has reduced recurrences, serious complications, and in many cases the need for excisional surgery.

R. L. EGAN, M.D.
University of Texas, Houston

X-Ray Visualization of the Placenta. H. G. Watson. *West. J. Surg.* 63: 151-155, March 1955.

The most accurate method of placental visualization is by means of soft-tissue radiography. The author recommends a soft-tissue lateral view of the abdomen with the patient erect, using a wedge aluminum filter, a true lateral view of the pelvis, and an anterior recumbent film of the abdomen. Oblique views are needed only occasionally.

The error for a series of 19 patients in whom a diagnosis of placenta previa was made roentgenographically was 10.5 per cent (2 cases). Radiologic exclusion of placenta previa in 42 cases was confirmed clinically without exception.

Two tables.

RICHARD E. BUENGER, M.D.
Chicago, Ill.

Gas in the Symphysis Pubis During and Following Pregnancy. John L. Williams. *Am. J. Roentgenol.* 73: 403-409, March 1955.

This is an interesting article which the author summarizes as follows:

"Roentgenograms of the pelvis of pregnant women near term revealed a streak of gas density in the symphysis pubis in 41.5 per cent [of 232 cases]. It is believed that this streak of decreased density is similar to the gas streak seen in joints of the extremities when traction is applied. Presumably the normal separation of the symphysis pubis during pregnancy results in a partial vacuum, and gas is released from the surrounding tissues into normal clefts in the fibrocartilage of the symphysis pubis.

"The gas streak may appear during the first trimester but is most commonly seen during late pregnancy, and it persists for as long as three weeks after delivery. The gas streak is not present when there is a marked degree of separation of the pubic bones or marked mobility at the symphysis."

The phenomenon appears to be a "normal" concomitant of pregnancy.

Nine roentgenograms; 2 graphs.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Arteriography of the Uterine Artery: Its Value in the Diagnosis of Uterine Fibromyoma, Tubal Pregnancy, Adnexal Tumour, and Placental Site Localization in Cases of Intra-Uterine Pregnancy. Ingmar Fernström. *Acta radiol., Suppl.* 122, 1955.

The technic described by Borell *et al.* for percutaneous retrograde arteriography of the iliac artery (*Acta radiol.* 38: 247, 1952. *Abst. in Radiology* 61: 458, 1953) formed the basis for earlier work on the application of arteriography of the uterine artery in diagnosis of uterine myomas, adnexal tumors and the study of pregnancy and placental localization. The method, however, allows filling of the ipsilateral uterine artery only. With the technic described by Seldinger (*Acta radiol.* 39: 368, 1953. *Abst. in Radiology* 62: 466, 1954) and employed by the author, both uterine arteries may be filled simultaneously. Following percutaneous cannulization of the femoral artery and the application of compression to both femorals, a catheter is inserted to the level of the aortic bifurcation and the contrast medium is introduced, visualizing the iliacs and their branches on both sides.

In the present monograph the technic of injection

and normal anatomy of the uterine and adnexal vessels are described in detail. Most of the pertinent literature is reviewed and there are ample roentgenograms and drawings.

In all, 448 cases were examined. Of these 271 were excluded because no operation was performed to verify the clinical findings. The remaining 177 include 13 control cases, 84 gynecologic cases, 21 cases of tubal pregnancy, and 59 cases of intra-uterine pregnancy. No noteworthy complications were observed. There were no abortions and no induction of labor due to the procedure, either early or late in pregnancy.

Diagnosis was correct in 23 of 35 cases of uterine fibromyomata. Those missed were small tumors, fibroids showing degenerative change, and some of the tumors in postmenopausal patients. In the latter instances a disturbance of vascular supply may have been responsible for the failure. Diagnostic features of fibromyomata were: (1) lateral displacement of the uterine artery in its course along the lateral margin of the uterus, and loss of the normal tortuosity in this part; (2) the presence of non-tortuous intramural blood vessels in the vicinity of the tumor, capsular vessels, or vessels within the tumor.

It was possible to make the diagnosis of tubal pregnancy where the blood supply of the placenta was derived from the uterine artery rather than the ovarian artery, and the placenta or its remains were still connected with the blood vessels in the tubal wall. In such cases the tubal branch of the uterine artery often gave off distally several branches, some of which were non-tortuous and arched, and visualization of placental sinuses was obtained from the fifth week of pregnancy. Ruptured tubal pregnancy or tubal abortion was apt to be overlooked because of severance of connection between the placenta and vessels of the tubal wall.

In cases of adnexal tumor, the tubal branch or ovarian branch was non-tortuous and arched in about one-third of the women studied. Blood vessels were often visible in solid tumors but not in the cystic types. When it was not possible to visualize the ovarian and adnexal arteries by retrograde injection, the examination was often supplemented by translumbar aortography. Pelvic arteriography assumed special value in cases where clinical differential diagnosis of adnexal tumor from uterine fibroid presented difficulty.

As the pregnant uterus enlarged, there was the expected lateral displacement of the uterine artery in its course along the lateral margin of the organ, beginning in the third month and increasing as pregnancy progressed. There was loss of tortuosity of this part of the artery, late in multiparae and early in nulliparae. As pregnancy advanced, the intramural blood vessels supplying the placental sinuses increased in width and on reaching the sinuses increased in tortuosity. Irregular opacities, representing the placental sinuses, were visible from the third month to term in all cases. The technic was of special value in placenta previa, where other diagnostic methods failed to provide reliable information.

Ninety-five roentgenograms; 50 drawings; photographs and tables.

JOHN F. RIESSER, M.D.
Springfield, Ohio

THE GENITOURINARY SYSTEM

The Present Status of Renal Angiography. E. W. Riches. *Brit. J. Surg.* 42: 462-470, March 1955.

The authors perform renal angiography by means of

percutaneous aortic puncture just above the renal arteries, followed by injection of 30 c.c. of Diodone. While they prefer the lumbar route, a femoral approach is indicated if an aortic aneurysm is suspected. Cassettes are changed manually and the examination is made under general anesthesia.

The method is of particular usefulness in making the distinction between a renal parenchymal tumor and a solitary cyst, since circumstances may justify abstention from surgery in the case of a cyst. The malignant tumor presents a mottled appearance due to pooling of contrast medium in the vascular spaces. In a solitary cyst the vessels curve around the mass, which is avascular. When the main renal artery is visualized and is of good size, it is possible to excise the cyst and conserve the functioning kidney tissue. Exclusion of a renal neoplasm may be possible by angiography when other diagnostic means are inconclusive.

No specific angiographic pattern is obtained with tumors of the renal pelvis. If the ureter is obstructed by the tumor, only a faint nephrogram will result. If the parenchyma is invaded, this area will be avascular.

In polycystic disease of the kidney, the aortogram gives little information which is not obtainable by other methods. The typical picture of poor blood supply with bilateral avascular areas is noted. Aortography should not be done in these cases if there is poor renal function.

Angiography affords valuable information concerning renal function and the presence or absence of accessory vessels in hydronephrosis. The aortogram is a better test of renal function than the intravenous pyelogram. Both the degree of reduction in size of the main renal artery and the number of peripheral branches can be determined. The density of the nephrogram is also an indication of function provided the point of the needle is equidistant from the right and left renal arteries. Care must be taken in interpreting nephrographic findings if the contrast material is injected at a point closer to one renal artery than the other. The presence of aberrant lower polar vessels is no proof that they are the cause of obstruction at the ureteric-pelvic junction, but such proof can sometimes be obtained.

In any condition in which partial nephrectomy is contemplated, as hydrocalicosis or renal calculus, the renal angiogram is valuable in delineating the blood supply of the kidney.

Congenital anomalies such as absence or duplication or ectopia of the kidney are often verified by renal angiography. Results in renal tuberculosis have been disappointing, in that cortical cavitation is not demonstrated and the pyelogram gives more accurate information.

Twenty-five roentgenograms; 1 photograph.

RICHARD E. BUENGER, M.D.
Chicago, Ill.

Experience with a New Urographic Agent—Hypaque. G. M. Tice. *J. Kansas M. Soc.* 56: 130-132, March 1955.

Two hundred and eighteen patients between the ages of seven and eighty-five years, selected at random, were injected with a new intravenous pyelographic agent, Hypaque. This medium is a white crystalline solid containing 59.87 per cent iodine and is highly water-soluble.

The usual technic of injection was followed, and an effort was made to establish injection times and optimal

times for taking of the film. In the absence of reactions in the first 40 patients tested, injection speed was increased until the complete 30-c.c. injection was made in one minute. Of the patients studied, 91.8 per cent were completely free from any side-effects. Excellent results were obtained in 59 patients; good results in 97; fair in 43; poor in 14; in 4, no excretion of the medium took place; in 1, examination was discontinued as a result of reaction at the site of a test dose.

The author considers that the density of the agent, its dependability and speed of concentration, and the general lack of discomfort experienced by the patient cause it to compare favorably with other media at present available.

Two roentgenograms; 1 drawing.

Total Tuberculous Calcification of a Kidney and Ureter. Lewis G. Jacobs. *Am. Rev. Tuberc.* 71: 437-440, March (Part I) 1955.

This is a report of complete calcification, in a tuberculous patient, of an unobstructed kidney and ureter, developing over a period of four and a half years. The patient during this time was under treatment for duodenal ulcer. He also had tuberculosis of the hip, with probable involvement of seminal vesicles and epididymis, and multiple draining scrotal sinuses.

Complete calcification of the kidney is considered pathognomonic of tuberculosis. In this, as in other infectious calcifications, the underlying process is calcification in damaged or necrotic tissue.

Renal calcifications may also occur as multiple, scattered, streaky or punctate areas or as single (or a few) isolated areas of irregular outline or density.

Two roentgenograms. DON E. MATTHIEN, M.D.
Phoenix, Ariz.

Renal Displacement and Rotation During Retroperitoneal Pneumography. John D. Cooney, Richard D. Amelar, and Abraham Orron. *Arch. Surg.* 70: 405-406, March 1955.

A case is reported in which displacement and rotation of the right kidney by retroperitoneal air introduced for diagnostic purposes occurred, causing suspicion of an extrinsic mass even though none could be seen. Films made four days later, after most of the oxygen was absorbed, showed return of the kidney to normal position, indicating that the gas alone had caused the displacement.

Five roentgenograms. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

THE ADRENALS

Pheochromocytoma—Localization by Aortography. C. H. Snyder and L. J. Rutledge. *Pediatrics* 15: 312-316, March 1955.

Pheochromocytoma must always be considered in the differential diagnosis of serious hypertension in childhood. Once the diagnosis has been established by one of the various pharmacologic tests, localization becomes important for surgical relief, as the tumor may occur in either of the adrenals, the sympathetic ganglia, the carotid bodies, organ of Zuckerkandl, or even the urinary bladder. The usual means of localization are palpation, flank massage, plain film examination of the abdomen for a mass or calcification, excretory urography, and perirenal or presacral air injection, but these are not always successful.

The authors present a case in which direct trans-lumbar aortography with 20 c.c. of 70 per cent Urokon demonstrated the suspected tumor. The right adrenal artery was seen to ramify in a large round mass above the right kidney, while the venous phase of the study showed coronal displacement of the larger veins covering the capsule of the tumor. Surgical removal of a benign pheochromocytoma resulted in complete relief of symptoms.

Femoral artery catheterization is preferred for aortography in infants because of the mid-line position of the aorta. In older children and adults, direct paralumbar injection may be done. The only complication in the authors' experience to date has been transient anuria in a case of coarctation of the aorta.

Two roentgenograms.

MERRILL I. FELDMAN, M.D.
New Haven, Conn.

MISCELLANEOUS

Occult Carcinoma of Breast. Value of Roentgenography. J. Gershon-Cohen, Helen Ingleby, and M. B. Hermel. *Arch. Surg.* 70: 385-389, March 1955.

The authors use the term "occult" to describe cancer of the breast which cannot be palpated but is demonstrable by radiography. They have seen 5 such cases in over 1,000 patients referred for breast radiography. Three of them had palpable axillary nodes and 3 had eczema or other suspicious skin changes around the nipple which led to the request for radiography.

Radiographically 1 case showed only punctate calcification throughout the breast, which the authors claim is characteristic of duct carcinoma. At surgery extensive infiltration by duct carcinoma was confirmed. In 2 other cases masses with dendritic extensions were demonstrated by x-ray and found at operation. In 2 cases both masses and calcification were present.

[These reports are interesting but, since 3 of the patients had axillary metastases at the time of examination, the x-ray diagnosis seems chiefly of academic interest.—Z.F.E.]

Five roentgenograms; 6 photomicrographs.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Retroperitoneal Liposarcomas. Ted. F. Leigh and James V. Rogers, Jr. *J. M. A. Georgia* 44: 142-146, March 1955.

Liposarcomas are reported to be the most common sarcomas of the retroperitoneal space. They are the only ones of the common soft-tissue sarcomas showing some degree of radiosensitivity, and this in some instances may be striking.

The authors report 5 cases of liposarcoma originating in the retroperitoneal space. In 2 cases, the diagnosis was made from the roentgenographic findings alone. Since the tumors contain both fatty and non-fatty elements, the criterion for roentgen diagnosis is the presence of sufficient fat in the tumor to give a relative translucency on the films, but an amount insufficient in extent to account for the entire mass.

Nine roentgenograms. ARTHUR S. TUCKER, M.D.
Cleveland Clinic

X-Ray Visualization of Surgical Sponges. Thomas M. Thompson. *Surgery* 37: 455-460, March 1955.

Since there is no absolutely certain means for pre-

venting the overlooking of surgical sponges, the use of those containing an x-ray-detectable material is desirable in surgery of the abdomen and thorax. At the present time sponges with barium-sulfate-treated inserts are most commonly used. Because of the heavier atomic weight of lead as compared with barium, lead glass thread has been suggested for this purpose. An investigation by the author, however, revealed that barium sulfate-coated monofilaments are more easily visualized.

While the best roentgenographic delineation of such sponges is achieved with conventional x-ray equipment and the Potter-Bucky diaphragm, highly satisfactory roentgenograms are easily obtainable with portable equipment and stationary grids. Exposure technics should be used which would be expected to show the best osseous detail in the area of suspected sponge loss.

The adverse obscuring effects of uncontrollable respiratory motion are of greater magnitude in the thorax than in the abdomen. When a negative roentgenogram is obtained with portable equipment under these circumstances, it is recommended that a subsequent check be made with conventional equipment when the patient can cooperate in holding the breath.

Two roentgenograms.

Results of Intraperitoneal Injection of Barium Sulfate Contrast Medium. An Experimental Study. Saul Kay and Sun Hak Choy. *Arch. Path.* 59: 388-392, March 1955.

An investigation was made of the effect of barium sulfate injected into the peritoneal cavity. Since previous experiments with dogs seemed limited as to both the number of animals and the length of observation, white mice were used and the observation period was extended to six months, which corresponds roughly to twenty years in man.

A sterile barium suspension was injected into the peritoneal cavities of 21 albino male mice, nine weeks old. One group of animals received 1 c.c., a second 2 c.c., and a third 3 c.c. Three control mice were injected with corresponding doses of sterile saline. On a comparative weight basis, 1 c.c. of material injected into mice is equivalent to more than 2,000 c.c. in man.

The basic response to the injected barium was a granuloma, noted as early as the fourth day and chiefly histiocytic in type. The granuloma became progressively more fibrous in nature as the period of observation increased. With the larger barium doses, rather dense fibrous adhesions were produced between loops of intestine and surrounding viscera. The ultimate effect appeared to be non-deleterious to the host aside from intestinal distention, which was severe only with the largest dose employed.

Eight photomicrographs; 2 photographs.

TECHNIC

Practical Photographic Problems in Radiography, with Special Reference to High-Voltage Technique. Ove Mattsson. *Acta radiol.*, Suppl. 120, 1955.

The author introduces his monograph on high-voltage radiography with a general survey of the technic, pointing out its advantages, of which the most important are probably the short exposure times required and the possibilities of using fine foci.

A series of the author's own investigations illustrate, with the aid of graphs, some of the most important fac-

tors concerning radiography at higher voltages. His studies were made with a constant potential circuit up to 180 kv, and in conditions similar to those of ordinary radiography. The exposure required for unit film density with screen-film combination and non-screen film showed a marked reduction with increasing voltage, which was especially obvious with the former material. A further analysis of the problem shows that this reduction is to be explained, first by higher radiation output of the tube and secondly by higher penetration of the object. Thirdly, the sensitivity of the photographic material, screen-film combination and non-screen film, respectively, plays an important part. The former shows a steady increase in sensitivity to radiation of higher energies, but the latter a moderate reduction. The conditions of dosage are illustrated by graphs which show that the reduction of dose is not really quite so distinct as is generally believed. The effect of additional tube filtration upon dose and exposure is also shown.

The change in contrast of different substances with voltage variations is reported on the basis of photographic tests. The substances studied included salts of iodine, barium, and calcium, as well as water and paraffin, which represent soft tissues and body fat, respectively. With heavy substances containing barium and iodine, there is a reduction of contrast with increased voltage, but with the lighter substances the change is slight. Calcium salts stand apart, showing exceptionally low contrast at the higher voltages. The recording of the contrasts depends on the character of the photographic material in question, and there is a difference in result between films with screens and non-screen films. The latter, which are less sensitive to harder rays, were found to record the contrasts better, since the filtering action of, for instance, the heavier substances gives a harder radiation.

The influence of processing upon the photographic recording of contrasts is reported. The importance of the gamma value and the shape of the density curve are discussed on the basis of tests. The shape of the density curve does not change with variations of voltage, but its location in the graphical system will change as the radiation sensitivity varies. The importance of correct development is pointed out, and ways of obtaining constant development with high contrast throughout long periods in everyday routine are discussed.

A retrospective survey of the screen problem is given as a background for a discussion of a new type of screen for medical radiography at higher voltages, containing barium lead sulfate as the fluorescent substance. The new screens are superior as regards speed, with an optimum at 110-120 kv, but give a much lower definition, which makes their value debatable. Certain properties of other screens are also discussed, and a brief comment on metal screens is made. In medical radiography lead screens seem to be of no value for intensifying purposes, at least in the region up to 180 kv.

Cross-grids, which, in connection with high-voltage technic, represent a superior solution of the problem of secondary diaphragming, have practically always been used without motion. Elimination of visible grid pattern in the film by proper motion is a main topic of the chapter on cross-grids, grid motion, and visible pattern. A review is first presented of the evolution of secondary screening with special reference to the role of the cross-grid principle. The absence of information concerning

the adequate motion of a cross-grid for homogeneous illumination of the film is pointed out. On the basis of photographic experiments, a geometrical analysis is made of the distribution of illumination behind a moving grid. The suitable directions of motion of the crossed-grid system for homogeneous illumination are defined, and applications to systems of different types discussed. Models of grid mechanisms made along the lines deduced have been used in angiographic examinations, etc., and have proved to give films completely free from any visible pattern.

The detrimental effect of a superimposed grid pattern on the definition of fine details is discussed, and tests are described which reveal a marked increase in the demonstration of details with the grid in motion.

One cause of irregular illumination of the film behind a moving grid is stroboscopy, *i.e.*, the phenomenon produced by intermittent radiation striking a moving object. The importance of a constant and selectively chosen speed for preventing this effect is pointed out.

A brief review is given of applied principles of motion of some modern grid mechanisms. The connection between the type of motion and the freedom from pattern obtained is discussed.

A construction of a grid mechanism suited for modern demands is outlined.

Off-focus radiation and back-scatter are among the factors which influence the quality of the radiographic image. A study of modern tubes was made with a pin-hole camera, and the principal source of off-focus radiation was shown to be in the focal plate. Ordinary primary diaphragms provide only incomplete elimination of this off-focus radiation, which is best reduced by placing a small diaphragm very close to the focus.

The backscatter phenomenon, which has not been much discussed in connection with radiography, is by no means without importance. Experiments presented show its effect in radiography with and without screens. Some simple methods for optimal reduction of its effect are discussed. The introduction of thin sheets of iron will prove favorable. Some related problems of importance for film changers are also commented upon.

Adequate studies of the possibilities of radiographic recording of certain objects are most easily made with phantoms. A phantom representing contrast-filled vessels was constructed, consisting of small channels cast within blocks of stearic acid and filled with an angiographic contrast medium. A microdensitometric comparison was made between the recordings of such contrast-filled channels and vessels of similar size in connection with pelvic angiography, in which the vessel phantom was introduced into the vagina. These investigations, made possible by the use of moving cross-grids, showed that the contrast medium will mostly not be subject to any dilution. This will probably be valid also for other examinations. The dimension of the smallest vessel that can be observed in the film is about 0.3 mm.

One hundred and eight illustrations.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

Cineradiography of the Cerebral Angiogram with the Philips Image-Amplifier Tube. H. Verbiest, J. Feddema, and J. Hardenberg. *Rev. mex. de radiol.* 9: 47-50, March-April 1955. (In Spanish)

In order to include the entire skull on the film, an improved version of the Philips (fluoroscopic) image-

amplifier tube was created with 270 mm. diameter of usable fluoroscopic screen and an amplification factor of 25X. The amplified image, already reduced in size, passes through Schmidt's correcting screen and is once more reduced in size by a large concave mirror. The film is positioned between the Schmidt screen and the mirror. A special device molds the celluloid in a spherical form to compensate for the mirror's convergent rays. The final image can be controlled at all times while the filming is in progress, an obvious advantage for adequate positioning.

The technical factors are: 6-kenotron triphasic x-ray transformer; 0.3-mm. x-ray tube focus; 1 mm. Al filter; 72 kv; 18 ma; Orthoscopic G 35-mm. Gevaert film; 16 frames per second. A continuous exposure of twenty to twenty-five seconds did not overload the x-ray tube and resulted in a patient dose of 6.5 r, to which must be added about 3 r required for the preliminary positioning. The adequate intensity of the x-ray beam was determined by photometric evaluation of the luminosity of the amplified image on the final (receiving) screen. A prismatic mask, made of plastic, prevented over-exposure at the periphery of the picture.

The satisfactory results obtained during examination of 10 patients appear promising for future research and should provide answers to many open questions in this and allied fields of endeavor.

One diagram. E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

"Geometric" Method to Calculate the Aortic Caliber from Anteroposterior Teleroentgenograms. Jorge Meneses Hoyos. *Rev. mex. de radiol.* 9: 42-46, March-April 1955. (In Spanish)

The width of the aorta cannot be measured directly on a frontal view of the chest because in this projection the vessel is not separated from the mediastinal shadow. To obviate the need for oblique positions, the author calculates the aortic diameter from measurements of the segment of aortic arch visualized on an anteroposterior film exposed with the target at a distance of 2 (or 1.8) meters. The formula offered is:

$$D = \frac{(C/2)^2}{A} + A \quad \text{where}$$

D = aortic diameter

C = chord of visualized segment of aortic arch

A = "arrow" of visualized segment (its greatest width, or the perpendicular uniting the midpoints of arc and chord)

The average aortic diameter, as determined by the author, is given as 32 (± 2) mm., standard deviations being 28 to 36 mm.; measurements of 35 to 40 mm. are within the pathologic range (dilated aorta). Accurate evaluation of the method by comparison with autopsy findings is difficult because the blood pressure increases the width of the aorta in the living individual. There are also variations due to differences between systolic and diastolic width (1 to 2 mm.) Magnification on the film also amounts to 1 to 2 mm.

The author believes that his formula (of limited value in syphilitic aortitis, which as a rule affects the ascending segment) should prove helpful in cases of aortic arteriosclerosis and aneurysm of the arch.

Two diagrams. E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

A Cardio-Roentgen Actuator: An Instrument for Actuating the Roentgenoscope in End Systole or End Diastole of the Heart Action. Frank W. Noble, Bert R. Boone, Harold T. Dodge, and Armand E. Brodeur. *J. Lab. & Clin. Med.* 45: 489-492, March 1955.

Roentgenograms of the heart and great vessels are routinely taken without reference to the phases of the cardiac cycle. For many purposes such a procedure is entirely satisfactory. Circumstances frequently arise, however, where the investigator desires the roentgenograms to be taken at known ventricular phases. So

taken, sequential films on the same patient become comparable, changing heart size during treatment can be observed, and physiologic differences at the several phases of the heart cycle may be studied.

The authors have designed an instrument which will actuate the roentgenoscope, take film exposures at any desired phase of the cardiac cycle, and place a marker on the simultaneously recorded electrocardiogram at the exact time of exposure.

Two roentgenograms; 1 diagram; 1 electrocardiogram.

RADIOTHERAPY

The Application of the Betatron to the Treatment of Brain Tumors. Arthur Arnold, Percival Bailey, Roger A. Harvey, and L. L. Haas. *South. M. J.* 48: 63-67, January 1955.

The authors describe the physical and therapeutic advantages of high-energy x-rays from the betatron for the treatment of neoplasms of the central nervous system. Their observations are based upon results obtained in 25 patients (16 with malignant lesions and 9 with benign lesions).

Twenty-two patients showed a favorable response. It is noted that the radiation can be directed with great precision and a highly uniform and effective tumor dose can be administered by appropriate cross-firing techniques. Generally radioresistant malignant lesions, such as the glioblastoma multiforme, were found to respond favorably to high-energy x-rays. Increased palliation and useful survival were reported for such cases.

Histologic studies of material obtained at autopsy or repeated operation have shown much more intense changes in the tumors treated by high-energy x-rays than have been observed in comparable cases following conventional roentgen irradiation.

Five illustrations.

Present-Day Treatment of Pituitary Adenomas. Surgery versus X-Ray Therapy. Gilbert Horrax, Magnus I. Smedal, John G. Trump, Richard C. Granke, and K. A. Wright. *New England J. Med.* 252: 524-526, March 31, 1955.

The authors report on 303 patients treated for chromophobe (243) and chromophile (60) pituitary adenomas at the Lahey Clinic over a twenty-one-year period ending in 1953. No basophilic adenomas are included in the group. In 143 cases the diagnosis was verified histologically; in the remaining 160 it was based on clinical and radiographic evidence.

A comparison of results is made for patients treated by radiation and surgery and by both. Any patient with chromophobe adenoma who showed improvement in visual deficits was considered benefited. Patients with chromophile adenomas usually received radiotherapy and were considered benefited if intractable headache or abnormal growth features were controlled. Patients with either type of tumor who failed to show improvement in visual deficit, or whose visual loss increased following radiotherapy, were subsequently treated by surgery.

Patients were divided into two main groups, those treated from 1932 through 1949 and those treated after 1950, when the 2,000,000-volt therapy apparatus became available. Of the earlier group of 125 patients treated primarily by surgical procedures, 79 per cent

were considered improved, for periods ranging up to eighteen years. During the same period 173 patients treated primarily by radiotherapy showed almost 60 per cent favorable results, but the remainder showed progressive visual loss requiring surgical intervention.

In the more recent four-year period, 1950 to 1953, of 53 patients receiving calculated tumor doses of 4,000 r by rotational supervoltage therapy, 80 per cent were sufficiently benefited so that surgery for visual loss was not necessary. The follow-up of this group is admittedly short but the results appear encouraging. The authors believe that a relatively high dosage of radiation (4,000 r in an unstated number of days) to the level of the hypophysis is necessary to produce the desired results. Earlier techniques at their institution did not deliver this amount of radiation. It is thought that the better recent results are referable to larger dosage and not specifically to supervoltage therapy, although such a modality makes for easier treatment.

Three tables.

J. W. BARBER, M.D.

Cheyenne, Wyo.

Radiotherapy of Cushing's Syndrome. J. F. P. Skrimshire. *Lancet* 1: 270-272, Feb. 5, 1955.

The author's findings supplement previous observations that the progress of Cushing's syndrome due to adrenal cortical hyperplasia may be arrested and considerable improvement may be achieved in suitable patients by irradiation of the pituitary gland. The treatment is simple; it involves no operative risk and is not followed by chronic adrenal insufficiency. Six cases are reported.

Deep x-ray therapy was given to the pituitary gland with a high-voltage unit (250-kv peak, half-value layer 1.75 mm. Cu). Six circular beams at 50 cm. focal skin distance were directed to the pituitary fossa with the aid of a plastic shell, through portals arranged around the hair line. A maximum dose of 4,000 to 5,000 r was given in twenty-eight to thirty days, the resulting skin dose being about 3,000 r. Larger doses are considered inadvisable because of the possible development of late cortical atrophy.

Four patients showed considerable improvement; in a fifth improvement was only temporary, and the sixth died of a cerebral hemorrhage five months after treatment was completed. In this last case some evidence of improvement in the Cushing's syndrome was present before death.

Pituitary irradiation is considered superior to surgery as the initial treatment of Cushing's syndrome. It is felt that "controlled Cushing's syndrome is a preferable existence to controlled adrenal insufficiency and that radiotherapy should be used before surgery is con-

templated." If the progress of the disease is not arrested within six to twelve months, surgical treatment can then be used with undiminished chances of success. One figure; 2 tables.

Small Cell Carcinoma of the Thyroid Gland of Youth. Joseph A. Buckwalter and L. K. Meredith. *Pediatrics* 15: 317-321, March 1955.

Carcinoma of the thyroid gland is a relatively common neoplasm in childhood. The most usual form is the slowly growing papillary type which metastasizes late in its course and is therefore ideal for surgical treatment. Supplementary radiation therapy in the form of radium implantation, radioactive iodine, or external radiation has been used with varying results. The small-cell, undifferentiated type is the least common histologic variety and responds poorly to both surgery and irradiation. The authors present a case of the latter type with a rapidly progressive course.

An eight-year-old boy had a slowly growing mass in the neck. The only presenting symptom was cough made worse by lying down and associated with wheezing respirations. The thyroid was enlarged, and hard cervical nodes were palpable bilaterally. At surgery, because of extensive invasion of surrounding tissues by tumor, only partial resection was done. Pathologic examination revealed pleomorphic, small round cells with many mitotic figures. Following operation, irradiation was given—3,000 r (air) to two ports—with no evidence of response. Administration of radioactive iodine was not attempted, because of a low uptake study. The subsequent course was progressively downhill, with death occurring seven months after cervical swelling was first noted.

Three other fatal cases are reported in the literature, but in none was the course so rapid.

One roentgenogram; 3 photomicrographs; 1 table.

MERRILL I. FELDMAN, M.D.
New Haven, Conn.

Some Problems of Current Interest Relating to Classification and Treatment of Uterine Carcinoma. James Heyman. *Am. J. Obst. & Gynec.* 69: 502-509, March 1955.

The author points out that, for therapeutic results in uterine carcinoma to be comparable, the figures to be compared must relate to material of equal clinical quality in respect to curability. Staging and comparison of stage rates are for the time being the only means by which comparability can be secured. The staging should be done, however, by experienced examiners. Surgically treated cases should be staged clinically for comparison of different methods of treatment. Non-invasive carcinoma should be reported separately from invasive lesions.

For evaluating the results of surgery in cervical carcinoma the author considers the following the only reasonable plan: (1) Classify all cases on the basis of the clinical findings prior to treatment. (2) Let the cases remain in that stage, irrespective of the operative findings. (3) Report on all cases of Stage I. Compare results in Stage I between institutions favoring surgery and those favoring radiotherapy. At present there appears to be no urgent need for primary surgery where adequate radiotherapy is available, as the five-year recovery rate in Stage I is 62.5 per cent at institutions favoring surgery and 65.3 per cent at those favoring radiotherapy.

For carcinoma of the corpus only two clinical stages are recognized: I to include lesions confined to the uterus and II to include spread beyond the uterus. Stage I is subdivided into Group 1, in which operation is considered advisable, and Group 2, technically operable but with some complicating disease or factor. Until statistically significant figures are obtained, the author feels there is little difference in the results of treatment of corpus carcinoma by the following methods: (1) hysterectomy followed by irradiation; (2) preoperative intracavitary radium therapy followed by hysterectomy; (3) primary intracavitary radium application followed by hysterectomy in case of failure.

Six tables.

R. L. EGAN, M.D.
University of Texas, Houston

The Treatment of Operable Cancer of the Cervix by the Combination of Radiation and Surgery. Report of 250 Cases. M. Dargent and G. Guillemin. *Cancer* 8: 53-58, January-February 1955.

The authors treated 250 patients with cancer of the cervix by radium or roentgen therapy complemented by an extended pelvic lymphadenectomy associated with a panhysterectomy or with a Wertheim operation. Joint participants in the treatment program were the staffs of radiation and surgery of the Anticancer Center at Lyons, France.

Application of radium in most instances was as follows: Three cork applicators, each containing 13.3 mg. of radium element, were placed in the vault of the vagina (two on each side of the cervix and one medially against it) and left in place for four days. A total dose of 28.8 mc was thus delivered. Three tubes of radium element, each containing 13.3 mg. of radium element filtered by 1 mm. of gold, were then inserted into the cervical canal and endometrial cavity; these also remained in place for four days. The same dose was thus delivered during each of the two sittings. In 19 cases deep roentgen-ray therapy alone was administered. These patients received a total of 6,000 to 7,500 r delivered between two anterior and two posterior pelvic portals, at 250 kv.

In 102 patients followed for more than three years, combined surgical and radiation treatment afforded a 65 per cent three-year cure. Of 25 patients operated upon five or more years earlier, 16 were still alive at the time of this report. Surgical mortality for the 102 patients was approximately 8 per cent.

Advantages and disadvantages of both surgery and irradiation are considered, and it is concluded that the combined method, using radiation for microscopic remnants of neoplasm and surgery for gross removal of lymph nodes and fatty tissue, is to be preferred. It is felt, however, that surgery alone may be indicated in certain instances of advanced but still operable lesions when a delay of six to eight weeks may afford the pelvic node metastases time to extend and adhere to surrounding tissues and thus become technically inoperable.

One roentgenogram; 4 photographs; 3 tables.

The Results of Radiation Therapy for Recurrent Cancer of the Cervix Uteri. Martin Van Herik and Robert E. Fricke. *Am. J. Roentgenol.* 73: 437-441, March 1955.

The authors studied 110 cases of recurrent cancer of the cervix encountered among approximately 1,200 patients with cervical carcinoma treated at the Mayo Clinic from 1940 to 1947 inclusive. No case was clas-

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sisted as a recurrence unless at least six months had elapsed between completion of primary treatment and diagnosis of recurrent disease.

Among the 110 cases, 96 had originally received irradiation only (usually a combination of radium and roentgen therapy), 11 had been treated by surgery alone, and 3 by surgery following irradiation. Squamous-cell carcinoma accounted for 90.9 per cent of the recurrences. A primary histopathologic diagnosis was obtained for all patients except one. Histopathologic proof of recurrence was obtained in cases in which the recurrence was accessible, with a single exception. Other accepted evidences of recurrence included pulmonary metastases in 6 patients, bone metastases in 2, and clinical evidence of parametrial involvement in 26.

Eighty per cent of recurrences occurred during the first two years following treatment. Only 3.6 per cent occurred after the fifth year.

All of the patients with recurrences were given radiation therapy; 4 received surgical treatment in addition. Twenty-five patients (22.7 per cent) lived more than three years following treatment for the recurrence, and 18 (16.4 per cent) lived more than five years. The better results usually occurred in patients in whom the recurrence was localized in the "accessible" pelvic organs, i.e., uterus, cervix, or vagina. Among the 18 five-year survivors, 17 had squamous-cell carcinomas, only 1 an adenocarcinoma.

Seven tables.

ARTHUR S. TUCKER, M.D.
Cleveland Clinic

Initial Clinical Results of Roentgen Therapy with a Grid in the Treatment of Advanced Cancer of the Uterus. Mino Bolognesi and Franco Bistolfi. *Ann. ostet. e ginec.* 76: 427-483, May 1954. (In Italian)

This report concerns 9 well studied cases of advanced carcinoma of the cervix treated with grid therapy. The authors emphasize the great importance of careful medical care of the patient before as well as during x-ray therapy, including such measures as repeated small blood transfusions and the use of amino-acids, liver extract, vitamins, hormones (androgen and adrenocortical), topical and parenteral chemotherapeutic and antibiotic agents. Not only does such supportive therapy add to the well being of the patient but it increases tolerance for the large x-ray doses administered. In addition, an anti-neoplastic effect is attributed by many authors to some of the steroids administered.

Usually, two large opposing pelvic fields, 15 × 21 cm., and 17 × 21 cm., with chess-board grids (50 per cent transmission and square openings of 1.5 cm.) are used. About 400 r (air) per field is given, one field being treated daily, five to six days a week, for a total dose of about 12,000 r (air) in thirty-five to forty days, resulting in an average dose in the center of the pelvis of about 4,000 r. Certain special techniques are discussed, such as use of complementary chess-board grids and the association of fields with and without a grid. For any given dosage, general and local tolerance to treatment is much higher with a grid than without.

The results obtained in these 9 cases, such as regression of enlarged pelvic infiltrations, control of pressure upon the ureters and pelvic nerves, local effects on the cervix, and control of metrorrhagia and foul discharge, indicate that grid therapy is a well worth-while palliative procedure. Its use is suggested also in cases in which a bulky tumor precludes efficient preliminary use of radium.

Added to the radiobiologic advantages of this method are the relative simplicity of execution and the limited cost of the accessory apparatus, factors which make it usable in the smaller centers.

This "poor man's supervoltage" is especially important in restoring the woman to her home and work in a relatively good functional state, even if for a limited time.

Fifteen figures, including 6 roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

A New Improved Type of Colpostat. Sidney M. Silverstone. *Am. J. Roentgenol.* 73: 481-483, March 1955.

The author has made some improvements in the colpostat used for treatment of cancer of the cervix uteri and other pelvic neoplasms previously described (*Am. J. Roentgenol.* 67: 294-299, 1952). Advantages claimed for the colpostat include ease of accurate placement in each lateral fornix under direct vision, maintenance of constant position throughout treatment, and a wide range of lateral spread of the radium sources which permits taking full advantage of the distensibility of the vaginal vault.

The improved model is made up of two component units, each consisting of an ovoid (containing a hollow cylinder in which may be fitted a capsule of radium) connected to one ring of a center locking device with a long handle. Both units are joined at the center locking device, which functions as a pivot and has an adjustable tension mechanism. The distance between the centers of the ovoids (hence the radium sources) is measured with a calibrated arc, which is removable.

The ovoids are made of nylon, which was chosen for this purpose because of its hardness, lightness, durability, and strength; all other parts are brass or steel. In the patient the ovoids are separated by approximating the handles. After gauze packing is placed around the center locking device, the handles are removed. They are attached again only at the time of removal of the colpostat.

Two photographs; 1 roentgenogram.

ARTHUR S. TUCKER, M.D.
Cleveland Clinic

Cytological Prognosis in Cancer of the Uterine Cervix Treated Radiologically. Ruth M. Graham and John B. Graham. *Cancer* 8: 59-70, January-February 1955.

A method of determining the radiation response in the vaginal smear of patients with cancer of the cervix is described in detail. The method is based on four changes in the *benign* squamous epithelial cells: vacuolization of the cytoplasm, nuclear changes, increase in nuclear and cell size, and the presence of multiple nuclei. If more than 75 per cent of the *benign* epithelial cells show any of these changes, the case is considered to show a good response from the prognostic point of view. If less than 60 per cent of the cells exhibit changes, the case is classified as showing a poor response. Five-year results in 142 cases of cancer of the cervix treated by radiation and divided into poor- and good-response groups are given. The five-year survival in the good-response group was 65 per cent in contrast to 8 per cent in the poor-response group. The broader implications of the method are discussed.

Eleven figures; 3 tables.

Prognosis in Irradiated Cancer of the Cervix by Measurement of Cell Size in the Vaginal Smear. Ruth M. Graham and Katherine R. Goldie. *Cancer* 8: 71-77, January-February 1955.

It has been observed that irradiation produces characteristic alterations in the non-malignant epithelial cells of the vaginal smear. Of these, increase in size is most obvious and most susceptible to measurement.

In this study, measurements of cornified and precornified cells of the vaginal smear following irradiation showed a size increase proportional to the effectiveness of the radiotherapy, as measured by the five-year survival rate in 100 cases of cancer of the uterine cervix. Thus, while only 25 per cent of 48 patients with an average cell diameter of less than 75 microns lived for five years, the five-year rate for 52 patients with an average cell diameter exceeding 75 microns was 61 per cent.

To determine the reproducibility of measurements, ocular micrometer and screen projection techniques were used by eleven technicians on the same smears of 19 patients. These showed an accuracy of 79 per cent.

It is concluded that cell measurement provides an inexpensive prognostic index similar to but somewhat less precise than that which can be obtained by radiation response judged by differential count.

Two photomicrographs; 4 charts; 6 tables.

Problems Associated with the Treatment of Cancer of the Endometrium. John M. Sadler. *Am. J. Obst. & Gynec.* 70: 17-28, July 1955.

The author has reviewed 99 cases of carcinoma of the endometrium in an attempt to evaluate the preoperative use of radium. These cases were staged according to a modified Finn classification:

- Stage I. Lesion confined to endometrium
- Stage II. Myometrium involved
- Stage III. Extension beyond myometrium but limited to reproductive organs (includes vagina, cervix, tubes, and ovaries)
- Stage IV. Involvement of other pelvic organs or pelvic lymph nodes (bladder and rectum)
- Stage V. Extrapelvic metastases (pulmonary, bone, etc.)

Of the 29 patients treated by surgery alone, 16 underwent hysterectomy without previous dilatation and curettage, and an additional 7 had a subtotal hysterectomy as there had been no preoperative diagnosis of carcinoma. Two patients had a vaginal hysterectomy, and in 3 Stage V cases operation was limited to exploration and biopsy. Except for these 3 Stage V patients, all of the surgical group lived three years without recurrence.

The usual method of preoperative radium application was the packing of two 50-mg. capsules in the fundus for a total of 5,000 mg. hr. Of 21 Stage I cases thus treated, 8 showed viable cancer in the resected specimen. The remaining 13 cases were believed to be of low malignancy and were for the most part cured by curettage. There was one recurrence in this group of 21 Stage I cases.

In 17 Stage II cases, radium failed to eradicate the lesion in 15. There were 5 recurrences in this group. Of 4 Stage III patients, 2 showed residual cancer and 1 had a recurrence. Cases of Stages IV and V were not benefited by surgery or radium.

Lesions treated by x-ray alone (4 cases) and radium

alone (22) were not staged. Three of the former and 7 of the latter recurred in three years.

The author feels that there is no evidence to support the idea that preoperative intrauterine radium eradicates tumor cells in Stage I cases or that tumor involvement outside the endometrium is affected by radiation. Its use is unjustified in the treatment of carcinoma of the fundus. The recommended therapy is a Wertheim operation with pelvic lymphadenectomy.

Three roentgenograms; 1 photomicrograph; 5 tables.

R. L. EGAN, M.D.
University of Texas, Houston

A System of Radium Distribution for Treatment of Cancer of the Corpus Uteri. R. Kenneth Loeffler. *Am. J. Roentgenol.* 73: 425-436, March 1955.

To fill the need for a dosage system for intracavitary radium treatment of cancer of the corpus uteri comparable to the several techniques in use for cervical cancer, the author proposes a scheme for delivering an effective dose to all parts of the uterus. No. 0.5 Heyman applicators are used within the uterus and Manchester ovoids in the vagina, although a modified Ernst applicator also can be used for the vaginal sources and lowest uterine source.

The number of intrauterine sources is varied according to the depth of the uterine cavity. The distributions of the applicators for shallow, medium, and deep uteri are (when the uterine cavities are symmetrical) respectively 5-1, 7-2-1, and 9-3-2-1, in radium units. A unit consists of 10 mg. radium filtered by 0.5 mm. platinum. These provide about two-thirds of the total dose, while one-third is supplied by intravaginal sources.

All sources are left in position for thirty-eight hours, which is about the time required to deliver 5,000 r to Manchester Point A (chosen as a reference point because it represents a sensitive area in the pelvis, corresponds roughly to the outer wall of the uterus, and is already in common usage for expressing dosage in gynecological cancer therapy). A range of dosage from 4,560 mg. hr. for a small uterus and vagina to 9,500 mg. hr. for a large uterus and vagina provides a constant exposure at Point A.

Distribution patterns and isodose charts are provided for a representative sampling of uteri of different sizes and shapes, including a number with bulky lesions of the fundus.

Seventeen figures, including 8 roentgenograms.

ARTHUR S. TUCKER, M.D.
Cleveland Clinic

Nitrogen Mustard and X-Ray in the Treatment of Pulmonary Metastases from Choriocarcinoma. Clayton T. Beecham, Augustin R. Peale, and Robert Robbins. *Am. J. Obst. & Gynec.* 69: 510-519, March 1955.

Two cases of choriocarcinoma with widespread pulmonary metastases are presented to illustrate the authors' belief that there is a promising field of potentiation of radiation effect on neoplasms by agents capable of influencing tumor biology.

The combination of 2,100 r (250 kv, half-value layer 1.7 mm. of copper, 70 cm. target-skin distance) mid-plane dose bilaterally in the chest in three weeks and 20 mg. of nitrogen mustard intravenously two-thirds of the way through the course of x-ray therapy was used in one patient. This was followed by disappearance

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of the pulmonary metastases and the patient was alive over two and one-half years later.

The second patient showed marked improvement for a short time and her Aschheim-Zondek reaction became negative. A tissue dose of 2,500 r was delivered to the middle of the thorax over four weeks; on the tenth day of therapy she received 17 mg. of nitrogen mustard intravenously.

Both cases are thoroughly reported. Originally it was the impression that both women were dying of pulmonary metastases and there was nothing to suggest spontaneous regression.

Six roentgenograms; 3 photomicrographs; 1 table.

R. L. EGAN, M.D.

University of Texas, Houston

Osteo-Epiphyseal Roentgen Therapy in Lipoid Nephrosis. Giuseppe Longo. Arch. di radiol. 29 (n.s. 3): 304-310, 1954. (In Italian)

This paper reports 2 cases of lipoid nephrosis in children of nine and five years, treated by roentgen irradiation of the epiphyseal areas. Details of the treatment were as follows: In the first case, 30 cm. target-skin distance, 0.5 mm. Cu and 1.0 mm. Al filter,

anterior and posterior ports (8×10 cm) over each shoulder, elbow, hip, and knee, 200 r daily to a single port, i.e., 16 treatments, totaling 3,200 r; in the second case, 16 treatments of 100 r daily in seventeen days, a second series of 16 daily treatments of 100 r in twenty-three days, and a final series of 16 daily 100 r treatments [probably air doses; all physical data have been included in the abstract]. This method was suggested by Pietro Cignolini (now of Messina).

Treatment appeared quite effective in these cases, and a causal relationship is claimed between the irradiation, subsequent biochemical changes (albuminuria, diuresis, proteinemia), and clinical improvement (subsidence of edema with ultimate cure). The application is nevertheless empirical, and so far no reasonable explanation for the effects obtained has been offered. At the time of publication, 2 other cases were under treatment.

[The above attempts are reported chiefly as a curiosity. This abstracter, at least, would require much more documentation before considering the method even in desperate circumstances.—E.R.N.G.]

E. R. N. GRIGG, M.D.

Cook County Hospital, Chicago

RADIOISOTOPES

Determining the Site of Brain Tumors. The Use of Radioactive Iodine and Phosphorus. Edwin W. Amyes, Paul H. Deeb, Philip J. Vogel, and Ralph M. Adams. California Med. 82: 167-170, March 1955.

The authors discuss the use of radioactive iodine and phosphorus in the diagnosis of intracranial tumors. Iodine is used for localization prior to operation, since gamma rays are given off which can be detected externally. Diiodofluorescein with radioactive iodine was originally used but was unsatisfactory because of rapid excretion by the liver. Much more useful results were obtained when the radioactive iodine was combined with human serum albumin.

Radiiodine was used in 138 patients thought to have intracranial lesions. Fifty of these patients had brain tumors which were confirmed by subsequent microscopic examination. In 11 instances, the location of the tumor rendered it unsuitable for gamma-ray counting, either because it was in the posterior fossa, where it was shielded by heavy muscles, or because it was in a mid-line position where equal counting rates were obtained on both sides. In 30 of the 39 remaining cases, foci were demonstrated showing a sustained increase in radioactivity of 10 per cent or more over that of the surrounding area; in 24 of the 30, the increased radioactivity was over the tumor. Better results were encountered when a higher differential of radioactivity was used as a criterion. For example, 19 cases exhibited local cerebral activity that was 24 per cent or more higher than that of the surrounding brain, and in every one of these the increase was over the site of the tumor. No case of false localization occurred in which the local radioactivity was increased by more than 20 per cent. Unfortunately, some lesser foci of increased radioactivity were encountered in diseases other than neoplastic, e.g., in 8 of 23 cases of idiopathic cerebral atrophy and in 10 of 12 cases of cerebrovascular accident. Only one false-positive response was obtained among 16 patients studied who had no other evidence of organic brain disease.

Greater accuracy was achieved with the use of radioactive phosphorus. Because this is a beta ray emitter, it is of value only in study of the brain when exposed during operation. Five hundred microcuries of radioactive phosphorus were administered intravenously, and the brain subsequently examined by a Geiger counter in the end of a probe 2 mm. in diameter, which was passed into the brain substance. The method was used in the study of 15 expanding intracranial lesions. Successful localization of a neoplasm was achieved in 14 of these. The single failure occurred in a patient with a brain abscess. Among the brain tumor patients, the radioactivity of the most active portion of the cerebral neoplasm was never less than five times the activity of the normal brain. In 1 case, that of a very vascular meningioma, the radioactivity of the new growth was sixty times that of the surrounding cerebral tissue.

One chart; 2 tables. ARTHUR S. TUCKER, M.D.

Cleveland Clinic

Lack of Effect of Fluorine Ingestion on Uptake of Iodine¹³¹ by the Thyroid Gland. J. Elliot Levi and Hannah E. Silberstein. J. Lab. & Clin. Med. 45: 348-351, March 1955.

There are historical reasons for suspecting that there may be a competitive relationship between fluorine and iodine in the metabolism of the thyroid gland. The iodide-trapping function of the thyroid as measured by radioiodine studies has proved to be an exceedingly sensitive test of one thyroid function and of the action of interfering substances such as thiocyanate. In 17 euthyroid subjects studied by the authors, no effect on iodide trapping was demonstrated as a result of the daily administration of 4 mg. of fluoride ion in the form of sodium fluorosilicate over a ten-week period. It is believed, therefore, that a dilute solution of fluoride in drinking water, of the order of 1 part per million, has no effect on radioiodine uptake studies of thyroid function.

Thyroidectomizing Dose of Radioactive Iodine in Humans with Malignant Melanoma. Levona W. Olmsted and William H. Beierwaltes. *Cancer* 8: 336-338, March-April 1955.

Animal experiments in which a higher concentration of I^{131} and I^{131} -labeled thyroxine and diiodotyrosine was obtained in tumor tissue than in non-tumor tissue led the authors to give thyroidectomizing doses of carrier-free I^{131} to 8 patients with widespread metastases of malignant melanoma. Biopsies performed afterward showed higher radioactivity in the tumor tissue than in muscle tissue. However, no effect on tumor growth was observed, regardless of tumor concentration of I^{131} or completeness of thyroidectomy.

Two figures; 1 table. DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

Experimental and Clinical Studies with Radioactive Colloidal Gold in the Therapy of Serous Effusions Arising from Cancer. Campbell Moses, Edward Kent, and Joseph B. Boatman, with collaboration of R. D. Cole, Joseph H. Sunder, R. S. George, Clem Russ, W. B. Ford, and E. R. Kutz. *Cancer* 8: 417-423, March-April 1955.

Using as a guide the observed effects in animal experiments, the authors treated 163 human patients with ascites and pleural effusions by intrapleural and intraperitoneal injections of colloidal Au^{198} . In rats, following intrapleural or intraperitoneal injection, the maximum concentration of radiogold occurred in the thymus. No significant complications were encountered with doses comparable to those used in man. Only mild reactions were observed in mice and dogs.

In approximately one-half of the human patients with metastatic carcinoma and pleural effusion or ascites, there was marked diminution in fluid formation. No serious toxic reactions were observed. The usual dose was 100 mc given in one injection. Pleural thickening of variable degree was later found at autopsy in several of the patients.

In the experience of the authors, radiogold is contraindicated in patients with intestinal obstruction. The risk of inducing enteritis outweighs the beneficial effect that might be anticipated. Au^{198} should not be given in the terminal few weeks of carcinomatosis, nor when significant pleural thickening is present without pleural effusion. It apparently has no value in the treatment of serous effusions from causes other than cancer, such as cirrhosis, congestive heart failure, or tuberculosis.

Five tables. DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

Use of Radioactive Gold in the Treatment of Carcinoma of the Bladder. Report of 8 Cases. Charles M. Nelson. *South. M. J.* 48: 245-250, March 1955.

Eight patients with carcinoma of the bladder were treated with radioactive gold, 5 men and 3 women between the ages of forty-seven and eighty-eight. The cases were far advanced and the treatment was regarded only as palliative. Three of the patients died and 5 were alive after brief periods at the time of the report.

The technic is as follows: The amount of gold required is estimated from the cystoscopic appearance of the tumor and from rectal and vaginal examination. Since the gold is active only over a distance of 0.5 cm., each cubic centimeter of tissue must be injected, the

area being estimated from the diameter and thickness of the tumor. Allowing 1 c.c. of solution to each cubic centimeter of tissue the total amount can be determined. The solution may be injected into the tumor after suprapubic exposure or, in the case of small tumors, through the cystoscope. Radiation protection measures employed in the procedure are described.

As the author states, too few cases have been treated and too little time has elapsed for far reaching conclusions. It is believed that the effect of radioactive gold on tumor cells is lethal in the areas injected in adequate concentrations; the effect on the stroma and on the surrounding structures is minimal, as evidenced by the rapid mucosal healing in all patients who lived long enough to be followed. It is felt that radioactive gold is as effective as radium and has the advantage of easier administration, better localization, and absence of adverse side effects. It does not have to be removed, and its activity is limited almost entirely to the area of injection. It is more easily administered than radon and can supply larger amounts of energy. It is not comparable to x-rays unless the x-ray therapy is aimed at a localized lesion, in which case the author believes that the short time required for administration of gold, absence of generalized reaction, minimal injury to surrounding structures, and the far greater amounts of energy which can be delivered to the tissues make gold the overwhelming choice.

Eight photomicrographs.

Effective Circulation of the Uterine Wall in Late Pregnancy Measured with $Na^{24}Cl$. Norman Morris, S. B. Osborn, and H. Payling Wright. *Lancet* 1: 323-325, Feb. 12, 1955.

The authors describe a method for the measurement of effective blood flow in the uterine wall during pregnancy, by use of the clearance-rate technic. In their series of observations 0.3 to 0.4 ml. of isotonic saline solution containing $Na^{24}Cl$ with an activity of 5 to 10 microcuries was injected directly into the uterine wall. A screened end-window gamma-ray Geiger-Müller counter was immediately placed over the site of the injection and the counting rates were recorded at one-half minute intervals on a counting rate meter. The results were expressed as the "time to half value" after a correction had been made for the rising background caused by an increasing amount of Na^{24} appearing in the blood stream after its removal from the injection pool.

Certain uncontrollable factors may considerably influence the clearance rate of $Na^{24}Cl$ from the wall of the uterus. These are chiefly (1) the effects of rhythmic uterine contractions, (2) the tonicity of the musculature, (3) the proximity of the injection site to the placenta, and (4) the depth of the injection from the peritoneal surface of the uterine wall. In this preliminary study no attempt was made to assess the influence of these factors.

Observations of the effective flow between the thirtieth week of gestation and term were made (1) on 20 normotensive women, (2) in 10 normal twin pregnancies, and (3) in 10 mild and 8 severe cases of pre-eclampsia. In twin gestation, the clearance rate was somewhat decreased compared with that in normal single pregnancy. The effective flow was about half the normal in mild, and only a quarter of the normal in severe cases of pre-eclampsia. Measurements suggest that therapy with hypotensive drugs in severe pre-

eclampsia increases the effective blood flow in the uterine wall.
One table.

Radioisotope Studies in Neuromuscular Disease.
2. Studies in Muscular Dystrophy and Myotonia Dys-
trophica with Sodium²² and Potassium⁴². William H. Bland, Franz K. Bauer, Raymond L. Libby, and Augustus S. Rose. *Neurology* 5: 201-207, March 1955.

Preliminary isotope studies in various neuromuscular disease states demonstrated a diminution of body potassium in patients with muscular dystrophy and myotonia dystrophica (*Neurology* 3: 604, 1953). The investigation was broadened to include the study of selected family members of muscular dystrophy patients. In addition, the body sodium content was determined by isotope methods in order to understand better other aspects of electrolyte metabolism in primary muscle disease.

Measurements of total exchangeable sodium and potassium by the isotope dilution method (utilizing radioactive sodium²² and potassium⁴²) in 33 patients with muscular dystrophy and myotonia dystrophica and 38 family members of patients with muscular dystrophy revealed a diminution in exchangeable potassium in the two diseases. The lowest values occurred in patients with childhood muscular dystrophy. Abnormally low exchangeable potassium values were obtained in 3 healthy male siblings of muscular dystrophy patients. Values obtained in parents and other siblings were within the normal range.

Exchangeable sodium was not significantly depressed; most values fell within the normal range. Intracellular sodium was normal, whereas extracellular sodium levels were slightly depressed.

Creatinuria was observed in all cases of muscular dystrophy but in none of myotonia dystrophica. Creatinine excretion was decreased in all patients.

There was good correlation between exchangeable potassium, creatinine excretion, and physical disability in most patients with muscular dystrophy and poor correlation in most patients with myotonia dystrophica.

The possibility of a critical level of body potassium is suggested, below which normal muscle function cannot be maintained, resulting ultimately in muscular atrophy and degeneration.

Three figures.

An Improved Method for Clinical Studies of Total Exchangeable Sodium Using ²²Na and a Whole-Body Counting Technique. N. Veall, H. J. Fisher, J. C. McClure Browne, and J. E. S. Bradley. *Lancet* 1: 419-422, Feb. 26, 1955.

The fraction of a tracer dose of a gamma-emitting isotope which remains in the body after a given time can be measured by a simple Geiger-Müller counter system. In persons receiving Na²², this technique permits direct measurement of the biological-decay rate and serial measurements of total exchangeable sodium. The biological half-life for healthy persons is about eleven days. The standard error of a single measurement of total exchangeable sodium is ± 3 per cent.

About 10 per cent of the total exchangeable sodium takes several days for complete equilibration; uncertainties due to this and to calibration errors caused by changes in shape or size of the subject can be reduced by suitably fractionating the administered tracer dose.

Body-sodium measurements may be continued indefinitely on the same person without exceeding the permissible maximum of radiation dosage, *i.e.*, 0.3 r a week. The technic is simple, enabling studies to be made on hospital outpatients. The whole-body counting technic is applicable in a wide variety of investigations.

Five illustrations; 2 tables.

Studies on the Uptake of Fe⁵⁹ in Rat Embryo, Placenta, Uterus and Mammary Gland. Gösta Magnusson, Ingmar Bergström, and Erik Odeblad. *Acta radiol.* 43: 227-232, March 1955.

Two rats were injected on the twentieth day of gestation with 200 microcuries of Fe⁵⁹ per kilogram of body weight, and the fetuses, placenta, and mammary gland were examined at intervals varying from one to five days following injection. Studies were also made on a newborn rat whose mother received the isotope seven days before death. Radioactivity was measured with a scintillation counter, and apposition autoradiography was performed.

High amounts of radioiron were found in the fetal blood, liver, choroid plexus, enchondral ossification zones, yolk placenta, and maternal mammary gland. The high uptake in the enchondral ossification zones is probably due to the presence of growing capillaries. The high uptake in the mammary gland is remarkable because the content of iron in colostrum and mother's milk is known to be very low.

Five figures; 2 tables.

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University of Arkansas

Uptake of Radioactive Sulfate by Elements of the Blood and the Bone Marrow of Rats. T. T. Odell, Jr., F. G. Tausche, and W. D. Gude. *Am. J. Physiol.* 180: 491-494, March 1955.

The uptake of S³⁵-labeled sulfate by myeloid cells of human bone marrow *in vitro* has been previously reported (Lajtha *et al.*: *Brit. J. Cancer* 7: 401, 1953). The authors' experiments, in which male Sprague-Dawley rats were injected intravenously (jugular vein) with 300 microcuries of S³⁵-labeled sodium sulfate in a volume of 0.2 c.c., demonstrated uptake of the isotope-labeled sulfate *in vivo* by platelets, megakaryocytes, and myeloid elements of the bone marrow. The results provide additional indirect evidence of the origin of platelets from megakaryocytes, and they also indicate a platelet life span of about four days.

Two autoradiograms; 2 graphs; 2 tables.

The Rate of Disappearance of Rb⁸⁶ from the Plasma, the Biologic Decay Rates of Rb⁸⁶, and the Applicability of Rb⁸⁶ as a Tracer of Potassium in Man With and Without Chronic Congestive Heart Failure. G. E. Burch, S. A. Threefoot, and C. T. Ray. *J. Lab. & Clin. Med.* 45: 371-394, March 1955.

The radioactive isotope of potassium, K⁴², has such a short physical half-life that it is not suitable for prolonged studies of potassium turnover. Since rubidium has been shown to enter to some extent into the "metabolic pool" of potassium, Rb⁸⁶ was employed in an attempt to trace potassium in the body of persons with and without congestive heart failure. Although such tracer studies are not precise, they are sufficiently accurate to permit generalizations concerning certain aspects of kaliokinetic phenomena for man.

Rb⁸⁶ and K⁴² employed simultaneously in one control subject and in another with moderately severe chronic

congestive heart failure revealed that the two tracers behaved similarly during the first two hours following the intravenous administration. The partitioning of K^{42} and Rb^{86} in the intra- and extravascular compartments also was similar.

Rb^{86} entered the erythrocytes relatively slowly. The concentration increased for five to eight days following intravenous administration before a decline began.

The biologic decay rates were defined directly for Rb^{86} and, with reservations, may be applied indirectly to potassium. About fifty-nine to one hundred-eighty-eight days were required for one-half of the administered Rb^{86} to be excreted in the urine and thirty-nine to one hundred thirty-four days for one-half to be excreted in the urine and feces combined.

Because of the lag in the loss of Rb^{86} from the erythrocytes, the distribution of the tracer and K^{42} between the erythrocytes and plasma was disproportionate.

The turnover rates were not altered in a predictable fashion by variations in dietary intake of potassium.

Sixteen figures.

Study of the Use of Rb^{86} as a Tracer for the Measurement of Rb^{86} and K^{42} Space and Mass in Intact Man With and Without Congestive Heart Failure. S. A. Threefoot, C. T. Ray, and G. E. Burch. *J. Lab. & Clin. Med.* 45: 395-407, March 1955.

An attempt was made to estimate Rb^{86} space and potassium space and mass with the use of Rb^{86} as a tracer (see preceding abstract). A study of 3 subjects, 1 control and 2 patients with congestive heart failure, indicated that sampling of plasma or an extracellular fluid compartment would not necessarily provide sufficiently accurate determinations of Rb^{86} space or potassium space and mass to make it possible to study these parameters by measuring the tracer and non-tracer in the plasma. However, sampling of a portion (erythrocytes) of the major (intracellular) compartment of rubidium and potassium could afford values of Rb^{86} space and potassium space reliable enough to furnish valuable information concerning potassium and rubidium metabolism.

Although the concentration of potassium in the plasma and erythrocytes of the subject with severe congestive heart failure was not lower than in the control, the calculated mass and space were smaller, indicating less cell mass or deficiency of body potassium.

The time course curves of space and mass recorded for a period as long as fifty days revealed marked fluctuations and therefore indicate the unreliability of measurements of space and mass from a single observation.

Three figures; 3 tables.

The Excretion of Radiorubidium, Rb^{86} , Radiopotassium, K^{42} , and Potassium, Sodium, and Chloride by Man With and Without Congestive Heart Failure. C. T. Ray, S. A. Threefoot, and G. E. Burch. *J. Lab. & Clin. Med.* 45: 408-430, March 1955.

In the studies described in this report, the excretion of Rb^{86} in the urine and stools and the excretion of potassium in the urine were measured. The greatest kaliokinetic and rubidiokinetic differences observed were concerned with urinary excretion. These differences existed for short periods of study with Rb^{86} and K^{42} , as well as over long periods of time for Rb^{86}

and K^{42} , and were largely quantitative rather than qualitative. Increased excretion of potassium was usually accompanied by increased excretion of Rb^{86} , though there were some exceptions to this, chiefly in the latter part of experiments, when the radiometric assay of Rb^{86} was inaccurate due to low levels of counts. Because of skimming, *i.e.*, excretion without entry into major cellular compartments, and lags in exchange, differences in the excretion of K^{42} and K^{40} from that of K^{39} would be expected, especially during periods of high intake of potassium. It is interesting to note that the rates of Rb^{86} and K^{42} across the vascular membrane showed no significant differences, yet at the same time the rates of transfer into the urine differed. This and the resultant differences in simultaneous specific activities of Rb^{86} and K^{42} in plasma and urine support differences in their renal excretory phenomena. Because of such differences it is apparent that Rb^{86} is not a precise tracer of potassium, but observation of excretion of Rb^{86} over prolonged periods provides valuable information concerning the behavior of the excretion of potassium.

Eleven figures; 4 tables.

Detection of Beryllium by Means of the $Be^9(a, n_\gamma)C^{12}$ Reaction. Erik Odeblad and Giuseppe Nati. *Acta radiol.* 43: 249-255, March 1955.

Upon irradiating beryllium with alpha particles of sufficient energy, a compound nucleus, C^{13} , in an excited state is formed. De-excitation may be accomplished in several ways. One of these the authors have used for the detection of beryllium in biologic samples. According to this, C^{13} becomes C^{12} , yielding a neutron and 4.4-mev gamma ray. By bombarding samples, with or without ashing, by alpha particles from P^{210} and recording the gamma rays, it was possible to identify the presence of beryllium. Other elements giving an appreciable gamma yield were boron, aluminum, magnesium, and fluorine; their pulse height distributions differ considerably from that of beryllium, however, and this could be monitored on an oscilloscope while taking a count. It is considered that with a more intense alpha source this nuclear reaction method of analysis of beryllium would probably be superior to the spectrographic method.

Five illustrations.

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Autoradiographic Study of the Distribution of Radioactive Particulate Chromic Phosphate in Liver, Spleen, and Lung of the Mouse. Erik Odeblad, Ernest L. Dobson, Anne-Marie Odeblad, and Hardin B. Jones. *Am. J. Physiol.* 181: 210-214, April 1955.

The authors investigated the localization of particulate radioactive chromic phosphate in the liver, spleen, and lung of mice to determine whether the concentration and distribution within these organs undergoes observable changes with time after injection.

Forty-eight adult male mice were injected with particulate chromic phosphate containing radioactive phosphorus. At intervals of five minutes to twelve days after injection, the animals were killed and autoradiographs were prepared from the liver, spleen, and lung. In some of the mice injections were repeated.

The following observations are based upon analysis of more than 400 radioautographs. In the liver, the uptake of radioactive material in the Kupfer cells after a single injection was confined to irregular areas of varied

size and shape which were not definitely correlated with the classical concept of the liver lobule. Evidence that repeated injections of the radioactive chromic phosphate do not appreciably change this localization is presented. It is assumed to be governed by some still unknown factor. No appreciable change in the distribution pattern with time was observed.

In the spleen, the radioactive material was localized in large cells at the periphery of the lymph follicles, and, to a slight extent, in the red pulp. At the dosage used, the spleen, considerably damaged by the beta radiation, shrank; this may explain the high concentra-

tion of radioactive material observed two days after injection. Subsequently, however, a release of the radioactive colloidal material became apparent.

In the lung, temporary emboli seemed to occur in the immediate post-injection period. In addition, a reticuloendothelial uptake in cells located in the capillary walls was noted. This material is considerably reduced five, seven, and twelve days after injection. Some evidence is presented for the migration of phagocytes containing radioactive material to the alveoli, with the possibility of subsequent escape in the sputum.

Five autoradiographs.

RADIATION EFFECTS

National Survey of Congenital Malformations Resulting from Exposure to Roentgen Radiation. Stanley H. Macht and Philip S. Lawrence. *Am. J. Roentgenol.* **73**: 442-466, March 1955.

Questionnaires regarding marriage and progeny were sent to 3,751 radiologists throughout the country, and to a control group of 3,858 physicians specializing in anesthesiology, ophthalmology, pathology, plastic surgery, and psychiatry and neurology. Completed questionnaires were returned by 74.1 per cent of the radiologists and 53.8 per cent of the control group. Of the non-radiologists who replied, 19.3 per cent had received frequent exposure to radiation-producing equipment (usually in operating rooms), and their reports had to be evaluated separately.

Among 5,461 offspring of radiologists and exposed controls, there were 2.56 per cent twins, 14.03 per cent fetal deaths, and 6.01 per cent congenital defects. In 4,484 offspring of unexposed controls there were 2.10 per cent twins, 12.22 per cent fetal deaths, and 4.82 per cent congenital defects. Normal offspring constituted 82.23 per cent of the unexposed group as compared to 80.42 per cent of the exposed.

Three hundred and forty-eight congenital defects were found in 328 abnormal offspring of exposed fathers (6.01 per cent); 229 congenital defects were found in 216 abnormal offspring of unexposed fathers (4.82 per cent). A wide variety of defects were reported. Anomalies of the sense organs were most frequent among both exposed (17.53 per cent) and unexposed (18.34 per cent) groups. A considerably higher proportion of heart, blood vessel, and blood anomalies was found in the exposed group (14.37 per cent) than in the unexposed (7.86 per cent). Unexposed persons reported a significantly higher (13.10 per cent) proportion of muscle and joint defects than did the exposed (7.47 per cent). A total of 88 neoplasms was encountered, 56 in the exposed group (1.03 per cent), and 32 in the unexposed (0.71 per cent).

No significant difference in the incidence of twins between exposed and unexposed groups was found. Fetal death rates of the offspring of the exposed group were slightly higher than those of the unexposed, but not significantly so.

The exposed group reported more offspring (21.19 offspring per 100 person-years of marriage) than the unexposed group (19.19 offspring per 100 person-years of marriage). After the age of thirty-five, however, the fertility pattern of the exposed group was found to decline below that of the unexposed.

Nine figures; 18 tables. ARTHUR S. TUCKER, M.D.
Cleveland Clinic

A Comparison of Fetal and Infant Death Rates in the Progeny of Radiologists and Pathologists. James F. Crow. *Am. J. Roentgenol.* **73**: 467-471, March 1955.

The author conducted a human genetic survey in 1951 which covered somewhat the same ground as that conducted by Macht and Lawrence (see preceding abstract) but was less exhaustive and covered a smaller number of physicians. Questionnaires were mailed to 1,027 radiologists and 1,036 pathologists. Usable replies were obtained from 655 radiologists and 530 pathologists. The letters sent out with the questionnaires simply solicited the physicians' cooperation without telling them the purpose of the study, whereas Macht and Lawrence in their covering letters carefully explained their purpose. The author believes that this difference in approach may have helped to avoid a biased response.

This study, like that of Macht and Lawrence, shows no statistically significant increase in stillbirths and miscarriages among the wives of radiologists. Infant death rates were also found to be similar among the progeny of radiologists and of pathologists, but were based on such small numbers as to have little meaning.

The author warns that no conclusion regarding the assessment of genetic effects can be reached from the negative results of this study, since only a small fraction of the total genetic damage would be detected as an increase in fetal and infant death rates in the first generation progeny.

Four tables; 2 figures.

ARTHUR S. TUCKER, M.D.
Cleveland Clinic

Beta Radiation Cataracts. James E. McDonald, William F. Hughes, Jr., and Vincent G. Peiffer. *Arch. Ophth.* **53**: 248-259, February 1955.

The authors describe an investigation to determine the minimum cataractogenic dose of radon and Sr⁹⁰ in rabbits. A kidney-shaped beta radon applicator previously described (Hughes, W. F., Jr.: *Tr. Am. Ophth. Soc.* (1952) **50**: 409, 1953) was applied over the inferior limbus or the central cornea of the left eye, the maximally active surface of the glass radon needles in contact with the globe being 5 × 7 mm. The right eyes were exposed similarly, using a Sr⁹⁰ applicator with an active surface 5 mm. in diameter and a surface output of 104 rep per second.

No qualitative differences could be detected between the eyes exposed to radon and those exposed to Sr⁹⁰. The latent period before the appearance of lens vacuoles and granules varied directly with the dose, being as little as two weeks after exposure of the limbus to 5 gm.-sec. of radon and one month after 5,000 rep of Sr⁹⁰.

Threshold cataractogenic doses of 0.2 to 0.5 gm.-sec. and 500 to 1,000 rep did not produce granules until four to five months after exposure.

After exposure of the limbus, vacuoles and granular opacities developed directly under the area of treatment. These opacities were seen in the far periphery just posterior to the ciliary processes, apparently in the subcapsular region of the equator of the lens. In subsequent months they assumed a triangular shape, with the apex of the triangle progressing as a band or thin line posteriorly and the opacities and fine vacuoles fanning out along the posterior horizontal suture.

Eyes irradiated over the center of the cornea presented a somewhat different picture. After a longer latent period, opacities appeared in the region of the posterior pole or off-center from it, subsequently migrating so that they surrounded the posterior horizontal suture. The density of the opacities corresponded directly with the dose, and there was a greater tendency to the development of anterior subcapsular vacuoles.

The minimum cataractogenic doses in the rabbits receiving limbal irradiation was about 500 rep, although other rabbits, exposed to 1,000 rep, did not show significantly more opacities. Definite posterior sutural opacities were obtained in two eyes exposed to 0.5 gm.-sec. By relating gram-seconds to rep and, by extrapolation, considering the results from smaller doses of rep, the minimum cataractogenic dose of radon applied over the limbus of the rabbit is probably about 0.2 gm.-sec.

In an additional series of 20 rabbits irradiated with the radon applicator, with the beta particles screened out by 1 mm. of silver, only one cataract was produced with doses as high as 64 gm.-sec., after five and a half months.

Seventy-three radon-treated human eyes, in which the cornea was sufficiently clear to allow study of the lenses, were re-examined through a widely dilated pupil. Of these, 45 had definite radiation opacities and vacuoles; 13 had questionable opacities, and 15 had no radiation opacities. The changes were in every respect similar to those seen in the rabbit experiments.

Tentative cataractogenic dosage schedules are presented.

The cataractogenic potentialities of beta radiation should be considered in the clinical use of beta radiation on the globe. Certain conditions may warrant the risk of cataract because of the visual disability caused by corneal disease, *e.g.*, severe vascularizing keratitis, vascularization complicating keratoplasty, and epithelioma.

Twelve figures.

Aminoaciduria Following Total-Body Irradiation in the Human. Elaine J. Katz and Robert J. Hasterlik. *J. Nat. Cancer Inst.* 15: 1085-1107, February 1955.

Following the accidental exposure of 4 laboratory workers to total-body irradiation with gamma rays and neutrons at levels between 25 and 180 roentgens equivalent physical (rep), total daily urinary amino acid excretion increased to as much as ten times the normal value. The quantities of individual amino acids excreted varied from 2 to 20 times normal amounts.

Abnormal excretion in both number and quantity of amino acids occurred as early as twelve hours following the initial exposure, indicating that the physiologic changes had become operative before this time. Abnormal amino acid levels were evident five months fol-

lowing exposure. Aminoaciduria was thus found to be a sensitive and early indicator of low levels of radiation exposure. No direct quantitative relationship between the radiation level and the degree of aminoaciduria was noted.

The authors believe that the aminoaciduria occurring after irradiation might result from the following: (1) decreased oxidation and utilization of amino acids by the liver and other tissues; (2) adrenal response to a stress situation; (3) changes in the threshold of renal tubular resorption of amino acids; (4) increased protein (tissue) break-down. In view of the response to an exposure of 25 rep, it is postulated that increased protein breakdown is not a major factor in producing the aminoaciduria found in these patients.

Four figures; 6 tables.

Industrial Hygiene and Medical Survey of a Thorium Refinery. Roy Albert, Paul Klevin, James Fresco, John Harley, William Harris, and Merrill Eisenbud. *Arch. Indust. Health* 11: 234-242, March 1955.

The authors report an investigation of the toxicological sequelae in workers engaged in the extraction of thorium and the rare earths from monazite. It is pointed out that a close analogy of the hazards involved in the radium dial industry and the thorium industry cannot be accurate, since the decay chain and descendants of thorium and uranium are different. The thorium series, as compared to the uranium series, would show a much higher gamma level in the advanced stages of processing but the equilibrium beta dose rate is only half that for uranium. The disintegration product thoron is the parent of a chain of solid radioactive decay products which present a potential hazard in the industry since these solid materials may adsorb on atmospheric dust. Thoron is essentially an alpha emitter.

Thus the refinery workers are exposed to various salts of thorium, thoron gas and its solid daughters, as well as gamma radiation from mesothorium. The portal of entry of the airborne materials is through the respiratory tract; however, a portion of the material deposited in the lungs is brought up and swallowed. Only a negligible amount of this ingested material is absorbed from the gastrointestinal tract and deposited in the skeleton. Thus the major hazard is irradiation of the lung. One worker who had died of a coronary occlusion was autopsied and an estimated equivalent of 14 mg. of thorium was analyzed in the lung. The calculated alpha radiation was 0.17 rep per week (1.7 rem per week considering the alpha relative biological efficiency as equaling ten). This is about five times higher than the accepted tolerance, but no histologic evidence of pulmonary radiation damage could be demonstrated. Four other persons employed in the plant showed x-ray evidence of minimal pulmonary fibrosis. It must be assumed that this fibrosis is unrelated to radiation or that these 4 individuals received a lung dose considerably higher than 1.7 rem per week.

It is noted that the fundamental assumption is that 300 millirem per week would be harmful to the lung. This figure, however, is derived from estimates of damage to blood-forming organs by whole-body gamma irradiation, whereas the radiological hazard to lung is cancer. The radiation dose needed to produce lung cancer in man is not known, so that the tolerance dose *per se* remains equivocal. On the basis of the lung cancer rate in the general population, the 700 refinery workers should show only 1 or 2 cases. It would have

been necessary to find 5 to 7 cases of lung cancer to be certain that the incidence was abnormally high. In this survey, only 1 case was discovered. It is pointed out, however, that the long latent period before the development of lung cancer (which has been observed to average seventeen years in the uranium mines) may preclude an estimate of the true cancer hazard in the thorium industry. In general, however, the thorium exposures are in excess of currently acceptable standards for uranium. One roentgenogram; 5 figures.

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Long-Term Effects of Acute and Chronic Irradiation in Mice. I. Survival and Tumor Incidence Following Chronic Irradiation of 0.11 r Per Day. Egon Lorenz, Joanne Weikel Hollcroft, Eliza Miller, Charles C. Congdon, and Robert Schweisthal. *J. Nat. Cancer Inst.* 15: 1049-1058, February 1955.

In a previous investigation, the authors found that when 45 LAF₁ mice were exposed to chronic gamma radiation at a rate of 0.11 r per eight-hour day for duration of life, an increase in life span over that of the 59 controls was seen. This increase was, however, not statistically significant, and the experiment was therefore repeated with a larger number of animals.

It was found that male mice exposed to gamma radiation under the same conditions from one month of age until death had a mean survival time of 783.1 days as compared to 683.5 days for non-irradiated males. This increase of 99.6 days is significant. The increase in mean survival time of female mice, similarly exposed, was only 17.4 days, which is not statistically significant.

An increase in the incidence of lymphosarcomas and other tumors of the reticular tissues occurred in both the male and female irradiated mice. Mammary carcinoma incidence was also higher in the irradiated animals. The increase in both cases was statistically significant at the 0.01 level. In addition, the irradiated females showed an increase in ovarian tumors and the irradiated males showed an enhanced lung tumor incidence.

Four graphs; 4 tables.

The Histopathology of Bacterial Infection in Irradiated Mice. Charles C. Congdon, Fletcher P. Williams, Jr., Robert T. Haberman, and Egon Lorenz. *J. Nat. Cancer Inst.* 15: 855-876, February 1955.

Bacteriologic findings have indicated that infection is a major factor in causing death of mice after total-body irradiation over a wide dose range. The present work was undertaken to determine the histopathology of the infection and to demonstrate morphologic lesions in the intestine from which bacteria gain entrance into the blood stream.

In two large groups of mice lesions in the intestinal epithelium were found as early as the third day following irradiation (900 r). These ranged from tiny microscopic necrotic areas to large bacterial ulcers. It is concluded that these lesions probably represent one portal of entry for the bacterial infection at the irradiation level employed. The inability of the blood stream to clear the organisms results in their settling out in capillaries, sinusoids, and lymph spaces throughout the body. The growth of bacteria in small vascular channels and the spread of the bacteria along the channel or through the wall into adjacent tissues constitute the basic feature of post-irradiation infection. The absence of an exudative reaction and pus formation is the only feature

that separates this process from the classic picture of a fulminating septicopyemia.

Fourteen photomicrographs; 1 table.

Long-Term Survival Following X Irradiation and the Irradiation of the α -Particles from Radon and Its Decay Products. Joanne Weikel Hollcroft, Egon Lorenz, Marion Matthews, and Charles C. Congdon. *J. Nat. Cancer Inst.* 15: 1059-1069, February 1955.

In a previous study (*J. Nat. Cancer Inst.* 12: 533, 1951. *Abst. in Radiology* 59: 635, 1952) the thirty-day LD 50 of x-radiation was found to be 1.42 times that of the alpha particles from radon and its daughters, exposures being based on the total energy absorbed. It was also shown that the short-lived decay products concentrated in the kidney, where they produced a dose 14 times the average. Alteration in the histology of a portion of the kidney in radon-treated mice, plus discovery of the high kidney dose in these animals, suggested renal failure as a cause of death. X-irradiated mice did not exhibit the same symptoms. The present investigation reports survival time in mice exposed to a near-lethal radiation dose by alpha particles from radon and its short-lived decay products. A comparison is made with survival time following x-irradiation with a comparable total-body exposure.

Three groups of mice were used: One was treated with 400 r x-irradiation; a second was injected with a dose of radon in equilibrium with its daughters, such that the absorbed energy was equivalent to that of 400 r; a third group was kept as a control. The mean survival time of the x-irradiated animals was found to be 425 days, that of the radon-treated mice 165 days, and that of the controls 377 days. A small serial killing study done on mice treated similarly showed that the shortened life span following radon treatment could be explained by renal damage, which was not found in mice of the other groups. Early kidney damage was also seen in the week following radon injection.

These findings indicate that the kidney damage caused by a high dose of irradiation from alpha particles may be in part responsible for acute deaths following radon administration. Since this damage is not seen after x-irradiation in the LD 50 range, the calculation of relative biological effectiveness based on an LD 50 dose of radon as compared to x-ray is not valid, unless the cause of death is known.

Two photomicrographs; 5 graphs; 2 tables.

The Radiation Recovery Factor: Preservation by the Polge-Smith-Parkes Technique. David W. H. Barnes and John F. Loutit. *J. Nat. Cancer Inst.* 15: 901-905, February 1955.

It has previously been shown that spleens of infant CBA mice, when injected intravenously as a mush, can lead to recovery of homologous adult mice given an otherwise lethal dose of x-rays. The authors found, in a series of experiments on mice receiving a dose of x-radiation which had proved to be uniformly lethal, that the recovery factor was not lost when the infant spleens were stored in glycerol-serum at 70° C. for as long as eighty-three days.

One diagram; 1 table.

On Wasted Radiation and the Interpretation of Experiments with Chronic Irradiation. R. H. Mole. *J. Nat. Cancer Inst.* 15: 907-914, February 1955.

The author describes an experiment contrasting the

effect, in mice, of continued daily irradiation until death and of a limited exposure to daily irradiation. One group of mice was irradiated five days a week until it had received a predetermined total dose of 200 r, 100 r, 50 r, 25 r, or 10 r daily; irradiation was then discontinued and the cage was observed until all the occupants were dead. Irradiation of the other group with doses of 800 to 25 r daily was continuous until death.

It is concluded that the killing efficiency per roentgen of a limited exposure is much greater than for continued irradiation since a great deal of the continued irradiation is wasted. When allowance is made for wasted radiation, the pattern of dose and effect for chronic irradiation becomes markedly altered. The irreversible consequences of a limited exposure are regarded as quantitatively important.

Three figures; 1 table.

Results of Exposure of Newborn Strain HR Mice to X Radiation. Margaret K. Deringer and Egon Lorenz. *J. Nat. Cancer Inst.* 15: 923-929, February 1955.

It having been observed that papillomas of the skin occurred in a small number of untreated haired and hairless mice and in 100 per cent of such animals following painting with 20-methylcholanthrene, a study was undertaken to determine whether the incidence of skin papillomas could also be increased by exposure to x-radiation. A total dose of 400 r x-radiation failed to increase the incidence of such growths in strain HR mice, but it was noted that the growths appeared in the irradiated animals at an earlier age than in the non-irradiated group (an average age drop of from 19.0 ± 1.4 months to 10.8 ± 2.21 months). A few squamous-cell carcinomas were observed in the irradiated hairless animals. The number of ovarian tumors was increased in irradiated strain HR females as compared with control females. Damage to the ovaries and testes of the strain HR animals was the principal result of the exposure to a total dose of 400 r x-radiation within twelve hours following birth.

One table.

Nucleic Acid Content of the Thymic Cells of Normal and Irradiated C57BL Mice. Patricia P. Weymouth, Norman E. Delfel, Ruth J. Doell, Helene L. Steinbock, and Henry S. Kaplan. *J. Nat. Cancer Inst.* 15: 981-990, February 1955.

In this investigation of biochemical events of possible importance in the tumor induction process, the authors divided young C57BL mice into a non-irradiated control group, a thigh-shielded irradiated group, and an unshielded irradiated group. The animals were killed at serial intervals for the determination of ribonucleic acid (RNA) and deoxyribonucleic acid (DNA) per cell in thymic cell suspensions.

The level of DNA per cell was found not to vary significantly with age or treatment. RNA values per cell, on the other hand, remained essentially constant with time in the control group but showed a roughly threefold increase one to five days after irradiation, with a prompt return to normal in the shielded group. In the unshielded irradiated group, the levels of RNA per cell and the ratio RNA/DNA remained elevated over the entire course of the experiment. Inasmuch as the shielded animals are known to be refractory to thymic lymphoid tumor development, and the unshielded animals highly susceptible, it is suggested that the sustained elevation of thymic cell RNA content may be re-

lated in some fundamental way to the genesis of experimental lymphoid tumors.

In parallel studies on the C43 transplantable lymphosarcoma, in which the normal thymus cells of the host C57BL mice were used as a control tissue, levels of RNA per cell as high as 900 per cent of normal were noted.

Two figures; 2 tables.

Effect of Local Roentgen Irradiation on the Formation of New Capillaries After Injury. Ruth M. Merwin and Elizabeth L. Hill. *J. Nat. Cancer Inst.* 15: 1031-1037, February 1955.

It had been noted previously that endothelium in irradiated areas shows a decreased capacity to form new capillaries; this may play a role in certain post-irradiation changes. The object of the experiments reported here was to study the effect of single doses of 400 to 1,500 r on the capacity of endothelium to produce new capillaries. An area of mouse skin was irradiated and, within six hours, was injured either by burning or by placing a stitch of tantalum wire through the skin.

It was found that a dose of 500 r slowed the rate of revascularization of the burned areas but had no effect on the time of vascularization of the coating of exudate that formed around tantalum wires. As the dose of radiation was increased from 500 to 1,500 r, the rate of revascularization of burned areas decreased and the interval before capillaries began to invade the coating around the wires increased. The new network of vessels in both types of injury was sparser after doses of radiation that exceeded 700 r than following lower doses.

Three figures.

The Effect of Fractionated X-Ray Dosage Upon the Mouse Testis. I. Maximum Weight Loss Following 80 to 240 r Given in 2 to 5 Fractions During 1 to 4 Days. Henry I. Kohn and Robert F. Kallman. *J. Nat. Cancer Inst.* 15: 891-899, February 1955.

Following exposure to x-rays, radiologic injury in the germinal epithelium of adult CAF₁ mice was measured by the maximum loss of testicular weight, which in the present experiments occurred at about four weeks after irradiation. The study covered undivided and fractionated dosage and a dose range of 80 to 240 r (tissue); the number of fractions was varied from 2 to 5, given in one to four days elapsed time. Physically equipotent, biologically equipotent, and non-equipotent fractions were used.

The degree of radiologic injury was proportional to the total dose, but it was not affected by fractionation within the limits used. This adds further support to the hypothesis, advanced previously, that one effective radiologic event inactivates one biologic unit, most likely a spermatogonium.

The authors' observations, together with those recorded in the literature, lead to the following synthesis, which is proposed as representing the available data relating to the rodent testes. "Extreme protraction and fractionation diminish injury. At dose-rates of about 0.1 to 100 r per minute the effect of fractionation is influenced by the size of the total dose. Doses of 100 r cause involution, but fractionation during a period of four days does not influence the amount. Doses of 600 to 2,000 r cause involution and also inhibit restitution. Fractionation of such large doses increases damage in the mechanism responsible for restitution."

One graph; 1 table.

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Fertility and Tumor Development in (C57L X A)F₁ Hybrid Mice Receiving X Radiation to Ovaries Only, to Whole Body, and to Whole Body with Ovaries Shielded. Margaret K. Deringer, Egon Lorenz, and Delta E. Uphoff. J. Nat. Cancer Inst. 15: 931-941, February 1955.

Previous studies of female hybrid mice exposed to long-continued total-body gamma irradiation demonstrated sterility effects, with some of the animals completely sterile and with others producing litters of reduced size. The authors have extended these observations to include effects of x-irradiation to the ovaries only, to the whole body, to the whole body with ovaries shielded, and to the whole body with ovaries and spleen shielded.

Mice in which the ovaries only were exposed to total doses of 300 to 500 r produced one litter and were sterile thereafter. Litter size was reduced as compared with that of untreated mice. Animals in which the ovaries only were exposed to total doses of 50 to 200 r produced multiple litters somewhat less in size than those of untreated mice. Only one litter, with reduced litter size, was produced by animals receiving total doses of 100 to 400 r to the whole body, except in the 100 r group. Mice receiving total doses of 12.5 to 50 r to either the ovaries or the entire body produced multiple litters, of comparable size with the untreated animals in the 12.5 and 25 r groups but with reduced litter size, as compared with the untreated animals, in the 50 r groups.

The breeding behavior of animals receiving 40 r with the ovaries shielded was similar to that of the control group. In animals receiving 900 r with the ovaries and spleen shielded, the average litter size was slightly reduced as compared with that of the controls.

Ovarian tumors occurred in all the animals receiving total doses of 300 to 500 r to the ovaries only and total doses of 100 to 400 r to the whole body, in some of the females receiving total doses of 50 to 200 r to the ovaries only, and in some of those receiving a total dose of 50 r to the whole body.

The greatest effect of x-irradiation was noted when animals received irradiation to the whole body, a lesser effect when ovaries only were irradiated, and the least effect when the whole body was irradiated with the ovaries shielded. Although the greatest effect was obtained when the whole body was irradiated, it was necessary that the irradiation include the ovaries. No effect was apparent when the whole body excluding the ovaries was irradiated other than that which could be ascribed to the operation itself.

Five tables.

Spontaneous and Radiation-Induced Pituitary Adenomas of Mice. Arthur C. Upton and Jacob Furth. J. Nat. Cancer Inst. 15: 1005-1022, February 1955.

Observations were made on tumors of the adenohypophysis developing spontaneously in a strain of mice, appearing first at about two years of age and occurring in more than 8 per cent of females surviving three years. It was found that the incidence of such tumors was increased by a single whole-body exposure to ionizing radiation, and that tumor formation was hastened in proportion to the dose.

Male and female mice, six to twelve weeks old, were exposed to ionizing radiations from a nuclear detonation. The animals were stationed at various distances from ground zero within thin-walled aluminum chambers that protected them from thermal and mechanical

injuries. Over 90 per cent of the radiations used were gamma rays, with a smaller component of fast neutrons, the neutron/gamma ratio varying with the dose. Approximately one month after irradiation the surviving animals were moved, individually caged and distributed in an air-conditioned room, and observed until natural death, a few being sacrificed *in extremis*. The LD 50 per thirty days was approximately 755 r; shortening of life occurred in proportion to the dose of irradiation received, significant reduction of longevity resulting even from the lowest dose studied, 192 r. Males survived slightly longer than females. Among the causes of death were leukemia, ovarian tumors, mammary gland tumors, and nephrosclerosis, all of which bore no discernible relation to the occurrence of pituitary tumors.

Frequency of pituitary tumors varied with radiation dosage and was approximately five times greater in females than in males. The neoplasms developed late in life, the earliest occurring ten months after exposure, and the rate of occurrence increased with age. The tumors developed earlier in irradiated mice than in controls, as a function of the dose. Tumors were not observed in females exposed to doses above 733 r or in males surviving doses above 785 r, owing probably to relatively early death with such large amounts of radiation.

The tumors were composed of cells predominantly chromophobic although containing in the cytoplasm varying numbers of coarse acidophilic granules; most neoplasms also contained at least a few heavily granulated acidophils which were interpreted as tumor cells.

Thirteen photomicrographs; 1 graph; 2 tables.

Successful Skin Homografts After the Administration of High Dosage X Radiation and Homologous Bone Marrow. John Michel Main and Richmond T. Prehn. J. Nat. Cancer Inst. 15: 1023-1030, February 1955.

It has been found that x-irradiation is one among several environmental factors that alter resistance to homografts by weakening the immune response of the host. Although such exposure has been shown to prolong the survival time of homologous skin grafts, the life of the host is shortened as dosage is increased. The authors attempted to prolong the survival time of homologous skin grafts in mice by treating the graft recipient with high doses of x-radiation followed by bone-marrow injection.

In order to obtain a uniform tissue dose, two x-ray tubes were placed opposite each other, above and below the box containing the mice, with a 54 cm. distance from the targets to the center of the mice. The tubes operated at 200 kv and 15 ma. The beams were filtered by 0.25 mm. copper and 0.55 mm. aluminum. A flat circular Lucite box, 6 inches in diameter and 1 inch in depth, accommodating 8 mice, was used as a container for the animals during irradiation.

Female mice (strain DBA/2JN) two to eight months of age, were divided into three groups. All were grafted twenty-four to thirty days after irradiation with skin from males (strain BALB/cAnN) two months of age. The first group received a dose of 350 r and were not injected with bone marrow. In the second group, dosage was 750 to 800 r, followed by immediate intravenous injection of bone marrow isologous to the recipients and homologous to the skin grafts. Dosage in the third group was 750 to 800 r, and irradiation was followed immediately by intravenous injection of hybrid bone marrow homologous to the recipient but with an antigenic component identical with the antigens of

the skin grafts. It was only in this last group that successful skin grafting occurred.

One photograph; 1 table.

Whole-Body Radiation as a Carcinogenic Agent.

Simon Koletsky and Gordon E. Gustafson. *Cancer Res.* 15: 100-104, February 1955.

White male rats of the Wistar strain were found to have an unusually high incidence of neoplasms after a single dose of 600 r total-body irradiation (about an LD 70 dose). The tumors were of a wide variety, both benign and malignant. They occurred especially in the skin and subcutaneous tissue, but also in the viscera. Both the frequency of neoplasms and the number of tumors per rat increased with duration of life. Individual rats often showed multiple diverse types of neoplasm.

One hundred twenty-three rats lived six months or more following the irradiation, and 69 of these had neoplasms. Forty-three had a total of 57 malignant tumors. There were 14 rats with fibrosarcoma, 8 with carcinoma of the skin, 8 with carcinoma of the kidney, 5 with osteogenic sarcoma, and 5 with neuroblastoma. Such tumors are apparently quite uncommon as spontaneous lesions, especially in the Wistar strain. Fifty irradiated rats had a total of 167 benign tumors.

In a control group of 36 rats, selected at random from the same population and at the same time as the irradiated rats, there were 8 with spontaneous neoplasms. Seven of these had a solitary tumor. Adenoma of endocrine glands was the most frequent neoplasm. No benign non-epithelial tumor was found. Only 3 rats had malignant neoplasms.

This study demonstrates the carcinogenic potency of whole-body irradiation. In addition to direct tissue injury, an indirect or systemic mechanism induced by irradiation may have been operative in promoting carcinogenesis.

Four photographs; 2 photomicrographs; 10 tables.

Cirrhosis of the Liver in Rats Following Total-Body X Irradiation.

Julius White, Charles C. Congdon, Philip W. David, and Mona S. Ally. *J. Nat. Cancer Inst.* 15: 1155-1164, February 1955.

The failure of rats ingesting a low protein diet to gain weight early in the period following total-body irradiation prompted the authors to study changes which might occur in some organs of these animals if they were permitted to continue on this diet for a prolonged period of time.

It was found that in 53 per cent (15 out of 28) of the rats which survived a 450 or 500 r total-body dose cirrhosis of the liver developed. Animals on either a 15 or 20 per cent casein diet, or a diet in which 15 per cent casein was replaced by an amino acid mixture for a thirty-day period, did not show cirrhosis for periods as long as four hundred days following exposure. Pulmonary infection was found to be a prominent cause of death in most of the groups of irradiated rats studied.

One photograph; 3 photomicrographs; 2 tables.

Level of Protein Intake and Nitrogen Excretion in Rats Following Total-Body X Irradiation.

Julius White, Bernard E. Burr, Harriett T. Cool, Philip W. David, and Mona S. Ally. *J. Nat. Cancer Inst.* 15: 1145-1154, February 1955.

The authors report the effect of various concentrations of protein intake on the rate of nitrogen excretion in

three groups of rats exposed to 450 to 500 r total-body x-irradiation. Irradiated rats fed a low-protein diet (6 per cent casein) showed marked increase in nitrogen excretion, while those ingesting a 15 per cent or 20 per cent casein diet exhibited a much lower increase. These increases are largely caused by greater urea excretion and suggest augmented protein catabolism. Food intake in all three groups was markedly reduced during the first three or four days following irradiation. As a result of exposure, loss of appetite ensued, and demands for energy from endogenous sources was more marked. Shielding the spleen of animals in the first group during irradiation resulted in partial protection against increased nitrogen excretion following exposure.

Nine graphs; 3 tables.

The Effect of Ionizing Radiation on Phagocytosis and the Bactericidal Power of the Blood. I. The Effect of Radiation on Migration of Leucocytes.

I. L. Shechmeister and M. Fishman. *J. Exper. Med.* 101: 259-274, March 1, 1955.

It is generally accepted that infection plays a prominent role in the morbidity and mortality that follow exposure to ionizing radiation. Under normal circumstances a host may protect itself against invading microorganisms by several mechanisms, among which are phagocytosis and the bactericidal action of the blood. In the quantitative evaluation of phagocytosis, the migration of leucocytes is considered an important factor. The present study is concerned with the effect of radiation on migration of rat and rabbit leucocytes at various post-irradiation periods.

It was found that exposure of rats to 600 r total-body irradiation did not influence either the rate or extent of migration of the leucocytes on the first day after irradiation but did increase migration on the second and the fifth post-irradiation days. Migration of rat leucocytes was not altered by infection of the animal with one strain of bacteria (*M. aureus*).

Leucocytes of rabbits irradiated with 100 r showed a normal rate and extent of migration. Rabbits exposed to 500 r to 800 r, however, showed depression of leucocyte migration at two post-irradiation intervals, on the third to the fifth and the tenth to the thirteenth day, with normal activity intervening. By the twenty-first post-irradiation day the ability of leucocytes to migrate returned to normal.

It was thus shown that irradiation of a host produced a two-phase depression in the ability of leucocytes to migrate. This depression could not be explained by the effect of the irradiation on total or differential white blood cell counts nor could it be ascribed to plasma factors.

Nine graphs; 6 tables.

The Effect of Ionizing Radiation on Phagocytosis and the Bactericidal Power of the Blood. II. The Effect of Radiation on Ingestion and Digestion of Bacteria.

M. Fishman and I. L. Shechmeister. *J. Exper. Med.* 101: 275-290, March 1, 1955.

This study, the second of a two-part investigation (see preceding abstract), deals with the effect of total-body irradiation on (a) the ability of leucocytes to ingest bacteria, as measured by the opsonocytaphagic index and the index of surface phagocytosis, and (b) their ability to destroy the ingested organisms. In addition, since it has been indicated (in the literature) that radiation de-

creases the bactericidal activity of serum, the effect of x-rays on the bactericidal power of the blood was studied in relation to phagocytosis.

Rats irradiated with 600 r (total-body) showed increased indices of both opsonophagic and surface phagocytosis two, twelve, and twenty-four hours later. The indices decreased seventy-two hours after exposure and returned to normal by the fourth to fifth post-irradiation day.

Bactericidal power of the blood of irradiated animals was depressed when measured three and six days after exposure to x-rays. Decomplemented serum from irradiated animals was more bactericidal against *M. aureus* than decomplemented serum from control rats. This bactericidal substance was destroyed at 78° C. and was found not to require any complement or specific antibodies for action.

Extracts of leukocytes from animals three days after irradiation demonstrated no bactericidal activity against *M. aureus*, while extracts from the control animals or from rats one day after irradiation were actively bactericidal. The extracts from the non-irradiated animals were thermolabile, non-dialyzable, had a pH optimum of 7.5, and were capable of precipitation by NH_4SO_4 and of calcium phosphate fractionation.

The observed increase in susceptibility of irradiated rats to infection with *M. aureus* was correlated not only with granulopenia but also with the alteration of the above indicated functions of the granulocytes of the irradiated animals.

One figure; 12 tables.

Leucocyte Adhesiveness Following Whole Body Irradiation. J. Philip Savitsky. *Am. J. Physiol.* 181: 215-217, April 1955.

It has been suggested that defects in the functions of individual leukocytes are responsible for decreased resistance to infection following whole-body irradiation. The present study demonstrates an abnormality in the adhesiveness of leukocytes of irradiated animals to glass.

Six healthy dogs received 400 r of whole-body irradiation (250 kvp, 15 ma, dose rate 25 r/min., target skin distance 100 cm.), which was an LD 90 dose. The animals were anesthetized with Nembutal prior to irradiation. Twelve guinea-pigs received 550 r (250 kvp, 15 ma, dose rate 50 r/min., target skin distance 70 cm.), LD 95. Increased leukocyte adhesiveness in the blood drawn from these animals was found within fifteen hours following irradiation, prior to the development of leukopenia. This alteration in adhesiveness appeared to be controlled by a substance in the plasma of the irradiated animals. The effect of the plasma, however, could be neutralized by a water-soluble, heat-stable, dialyzable substance found in beef spleen.

The physiological significance of alterations in the adhesiveness to glass of leukocytes is unknown at present. The increased adhesiveness following irradiation apparently plays little or no role in the subsequent leukopenia, since complete prevention of the change by the splenic extracts did not alter the course of the leukopenia or the survival of the animals.

Study of Recovery at Low Temperature of X-Irradiated *E. coli* Cells. A. W. Pratt, W. S. Moos, and M. Eden. *J. Nat. Cancer Inst.* 15: 1039-1047, February 1955.

While there is general agreement that the effects of

ionizing radiation on biological systems may be modified by changing the physical or chemical environment of the organism, there appears to be no general agreement as to what effect storage of the irradiated cells at low temperature may have in modifying the recovery pattern. The authors undertook, therefore, to determine the comparative recovery patterns obtained as a function of time when distilled water suspensions, citrate suspensions, and broth suspensions of *Escherichia coli* cells were exposed to x-irradiation and subsequently maintained at low temperatures.

Radiation was delivered to the cultures by a 186-kvp x-ray unit at a dose rate of 250 r per minute. For filtration of the beam, 0.25 mm. copper and 0.55 mm. aluminum were employed. A total dose of 3,000 r, measured in air, was given in all three experimental samples.

Some degree of recovery was found in all irradiated cell suspensions stored at 6° or lower, and it is suggested that the mechanism of recovery is intrinsic to the cell.

Two graphs; 1 table.

Influence of Extended Temperature Treatments on Recovery of X-Irradiated *Ascaris* Eggs. C. S. Bachofer and George Pahl. *Radiation Res.* 2: 50-63, February 1955.

Irradiation of eggs of *Ascaris lumbricoides* suum with 42,000, 54,000, or 60,000 r was found to produce cleavage delay and to interfere with normal embryogenesis. This cleavage delay remained unchanged when irradiated eggs, held at 0 and 5° C. for periods of thirty-five weeks, were subsequently incubated at 30° C. in order to initiate cell division. Survivals (completion of embryogenesis) showed a continuous decrease over the observation period of thirty-five weeks at 0 and 5° C., on subsequent incubation at 30° C. This decrease was most marked as a result of the first month of storage at low temperatures.

For maximum survival the post-irradiation temperature should approximate that for maximum biological activity. At this temperature restoration of essential cellular constituents and/or elimination of toxic irradiation products can best be accomplished, and it appears that some phase of metabolism is necessary to accomplish this.

The decrease in survival resulting from exposure to low temperatures after irradiation may be due in part to the action of low temperature itself, which brings about depletion of the minimal essential components needed for development and is evidenced even in unirradiated controls.

Over a period of one month at post-irradiation temperatures below 25° C. there is a complex pattern of survival. After one day there is a uniform decrease in survival with each decrease in temperature. After one week, the complexity involves bimodal curves.

At post-irradiation temperatures of 35 to 50° C. there is a decrease in survival with each corresponding increase in temperature. Irradiated eggs are more sensitive to temperatures above the optimal 30° C. than are unirradiated eggs.

Five graphs; 5 tables.

A Comparison of the Effectiveness of Radiations of Different Energies in Producing Chromosome Breaks. T. J. Arnason and Margaret Morrison. *Radiation Res.* 2: 91-95, February 1955.

Experimental results reported by previous investiga-

tors indicate that with any ionizing radiation of particular energy the frequency of chromosome breaks is directly proportional to the radiation dose. In this study, experiments were undertaken to determine chromosome breakage frequencies when similar cells were subjected to equal doses (as measured in roentgens) of rays of different energies.

Young *Tradescantia* buds with microspore nuclei in the "resting" condition were subjected to measured radiation doses. Three or four days after the beginning of the radiation treatments the cells were fixed and chromosomes at mitotic metaphase were examined for evidence of breakage. A 140-kev x-ray machine produced the least energetic rays used; a betatron operated at 23 Mev provided the radiation of highest energy. X-rays from a 200-kev machine and gamma rays of 1.25 Mev mean energy from a Co^{60} source were also used. Measurements of the physical dose in roentgens given to the buds were made with a Baldwin Farmer substandard x-ray dosimeter.

It was found that for equal dosage as measured in roentgens the rays of high energy produced fewer breaks than did those of lower energy. This finding is confirmed in the literature. The effects of the Co^{60} and betatron radiations differ only slightly; both produce fewer breaks than do 140-kev x-rays.

It is considered likely that differences in ionization pattern are in some way responsible for the observed differences in effects. The most effective radiations are those producing high average ion densities along electron tracks; the same (low energy) radiations also produce a relatively large number of ion clusters in electron-track tails per roentgen. The increase in chromosome breakage is, however, not directly proportional to the calculated increase in electron-track tails.

It appears unlikely that it is only in the tail region of electron tracks that the series of events culminating in chromosome breakage is initiated. With high-energy radiations, biologically effective ions or ion clusters other than those of electron-track tails must be produced with a frequency high enough to compensate, in part, for the relative scarcity of tails.

Two tables.

The Oxygen Effect on Radiation-Induced Chromosome Aberrations: Breakage-Versus-Recombination Hypothesis. Norman H. Giles. From the Symposium on Genetic Recombination, Supplement 2 of J. Cell. & Comp. Physiol., Vol. 2, May 1955, pp. 271-284.

The author discusses the effect of oxygen on the radiosensitivity of chromosomes to x-rays and reviews previous studies on this subject. His discussion deals principally with results obtained from the irradiation of *Tradescantia* chromosomes, where (as well as in other organisms) it is possible to achieve reasonably effective temporal separation of the breakage and recombination processes and thus test for oxygen effect on the separate reactions.

Results of experiments previously conducted show that oxygen affects aberration yield only when it is present during irradiation; furthermore, there is little (if any) lag between introduction of oxygen and its effect. The following conclusions are drawn: (1) to be effective, oxygen must be present during the actual x-ray exposures; (2) pre-treatment with oxygen does not sensitize chromosomes to subsequent x-ray breakage, as in the case of infra-red treatment; (3) the addition of

oxygen after an x-ray exposure has no effect on aberration yield. If breakage occurs in the absence of oxygen, it appears that its subsequent presence has no effect during the recombination of broken ends. Evidently, a reaction occurs when oxygen and x-radiation are both present to produce one or more substances which increase the aberration yield. The problem is whether such a substance causes an increased aberration frequency by increasing the initial breakage of chromosomes or by influencing the recombination of broken ends.

The author finds neither hypothesis conclusive. He notes the possibility that both differential breakage and differential recombination of broken ends may be involved in the reactions leading to aberration production, or that oxygen effect may operate by different mechanisms in different organisms. In any event, he considers that experiments dealing with the oxygen effect contribute to better understanding of the basic mechanisms by which ionizing radiations produce chromosomal aberrations, as well as other biological effects.

One table.

The Effect of Radiation from Small Amounts of P^{32} , S^{35} and K^{42} on the Development of *Arbacia* Eggs. James W. Green and Jay S. Roth. Biol. Bull. 108: 21-28, February 1955.

Arbacia gametes (eggs or sperm) exposed to radiation from S^{35} , P^{32} , and K^{42} at dose levels ranging from 0.25 to 5.0 μc per milliliter and subsequently fertilized with non-irradiated gametes, formed zygotes whose first cleavage was accelerated or retarded, depending upon the dose, and whose further development was slowed at the higher dose levels. Some experimental exceptions to these findings are reported and discussed.

While the knowledge that trace dose levels of these isotopes may cause biologically abnormal effects in *Arbacia* cannot be readily transferred to other types of cells, it would appear that rapidly dividing cells in the presence of radioisotopes, or, more important, cells which accumulate isotopes, may be modified in a subtle manner by the radiation emitted by these isotopes, even though the particular process studied does not appear to be altered. A greater awareness of potential cell damage from radioactive tracers should lead to further investigations and to more systematic knowledge of the limitations of these tools in biological research.

Eight photomicrographs; 2 graphs; 1 table.

Effects of Combined Local Treatment with Radioactive and Chemical Carcinogens. Arthur M. Cloudman, Katherine A. Hamilton, Ralph S. Clayton, and Austin M. Brues. J. Nat. Cancer Inst. 15: 1077-1083, February 1955.

In order to study the interaction of radioactive and chemical carcinogens, the authors conducted a series of experiments testing the effect of a carcinogenic hydrocarbon (methylcholanthrene) and agents emitting beta radiations in producing tumors of the skin and underlying tissues in mice.

The carcinogenic effects of the two agents applied to skin were approximately additive, although there was a suggestion of some synergism between them in the production of papillomas. When given in the form of subcutaneous pellets, the agents were somewhat less than additive. It is suggested that destruction of a local area of methylcholanthrene effectiveness by the

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Application of methylcholanthrene to the skin of young adult mice in an amount of 1.7 mg. in a single painting shortens survival of mice by about one-third. This effect is not shared by superficial beta irradiation in carcinogenic doses, by implantation of pellets containing carcinogenic doses of hydrocarbons or beta-emitting agents, or by the benzene solvent applied to the skin.

Five tables.

Some New Experiments on Protection Against Whole-Body Irradiation. A Lacassagne, J-F. Duplan, and N. P. Buu-Hoi. J. Nat. Cancer Inst. 15: 915-921, February 1955.

The authors describe three series of experiments, conducted at the Institut du Radium in Paris, to determine the protective effect of (1) certain phenolic and naphtholic compounds, (2) glucosamine, and (3) embryonic rat-liver suspensions against whole-body irradiation in mice.

For the test with phenolic compounds, each of the mice received, at varying times before irradiation, a single intraperitoneal injection of 0.5 ml. of a solution of the compound under study in neutralized olive oil. For some compounds, such as pyrogallol, resorcinol, and pyrocatechol, the solvent was physiological saline. It was shown that an injection of this solvent, or of a sodium salt of a fatty acid, had no effect on the outcome of irradiation. The irradiation factors were 180 kv, 10 ma, 0.3 mm. Cu, 65 r per minute; the dose, measured in air at a distance corresponding to the central region of the animal, was 700 r (100 per cent lethal in twelve days for the strain of mice involved). During irradiation the mice were enclosed in a specially designed plastic box. The non-injected controls were treated in exactly the same manner. Experiments with glucosides took place under the same conditions, with doses of from 580 r to 700 r for the injected mice and 580 r for the controls.

It was found that effective diminution of mortality and prolonged survival time are obtained with phenolic and naphtholic derivatives containing long-chain fatty acids. If the injection takes place more than one hour before irradiation, these chemicals afford no protection. Glucosamine administered a few minutes before irradiation also provides some degree of protection for the animals. Survival of rats receiving whole-body irradiation was increased by the post-irradiation intravenous injection of an emulsion of liver from fetal rats.

Five tables.

Some Biological Aspects of the Factor in Bone Marrow Responsible for Hematopoietic Recovery Following Systemic Irradiation. Mary B. Brown, Barbara B. Hirsch, C. Susan Nagareda, Sarah K. Hochstetler, William G. Faraghan, Paul Toch, and Henry S. Kaplan. J. Nat. Cancer Inst. 15: 949-973, February 1955.

Previous studies have shown that some unidentified material in mouse bone marrow reduces mortality, promotes hematopoietic regeneration, and inhibits lymphoid-tumor development in irradiated mice. The authors describe experiments in which thymic weight, fifty days after the institution of fractional total-body irradiation, was used as an assay criterion to obtain additional information concerning the nature and mode of action of the marrow. The results support the follow-

ing tentative conclusions: (1) Marrow cells enclosed in intraperitoneal capsules with a porous end-window gave no evidence that they elaborate a humoral material capable of dissociating from its cell of origin, traversing the window, and acting to promote hematopoietic regeneration in the irradiated host.

(2) Differentially centrifuged mouse bone marrow and spleen cells exhibited activity in the nuclei fraction, which was contaminated by non-disrupted cells to a variable extent, ranging from 10 per cent for marrow and sixty-day-old spleens to 0.2 per cent for seven- to ten-day-old spleens. Activity was inversely related to age of the source material, and not related to the degree of contamination by whole cells; these findings, which confirm those in the literature, are not considered entirely conclusive with regard to localization of the active material in the cell nucleus. The cytoplasmic and supernatant fractions were entirely inactive.

(3) The effect of thigh shielding and marrow cell injection is not dependent upon the presence of the spleen.

(4) Pretreatment of donor mice with phenylhydrazine or turpentine elicited an intense hyperplasia of the erythroid or myeloid cellular elements, respectively, of the marrow and spleen, but failed to modify activity in the thymic weight assay; it is tentatively suggested that this result indicates that the active factor resides in more primitive cells of the marrow and spleen.

(5) With the exception of fetal liver, all adult and fetal tissues other than marrow and young spleen were inactive. Marrow from strain A (Strong) mice and from rats exhibited no activity by this assay.

(6) Homologous marrow incubated *in vitro* with P³² and injected intravenously was distributed primarily in the reticuloendothelial tissues, with little in the thymus or blood. Most of the injected activity, however, could not be accounted for.

(7) Freezing or lyophilization of marrow resulted in inactivation.

Two figures; 15 tables.

The Time Factor in Inhibition of Lymphoid-Tumor Development by Injection of Marrow Cell Suspensions into Irradiated C57BL Mice. Henry S. Kaplan, Lincoln E. Moses, Mary B. Brown, C. Susan Nagareda, and Barbara B. Hirsch. J. Nat. Cancer Inst. 15: 975-979, February 1955.

It has been demonstrated that lymphoid tumor development in irradiated mice may be inhibited by shielding the thigh or the exteriorized spleen, or by injection of homologous bone-marrow cells following irradiation. Since the animals suffer the same degree of initial injury as irradiated controls, the effect appears to involve a reversal of the tumorigenic process in its early phase. To obtain some information as to the phase of reversibility in tumor development, the authors permitted graded intervals of time to elapse between completion of irradiation and intravenous injection of marrow.

It was found that maximum inhibition of lymphoid tumor incidence occurred when injection was carried out within one and one-half hours after the final x-ray dose. Over the range of time intervals studied (one-sixteenth of a day to thirty-two days) there was a gradual decrease in the inhibitory effect of the injected marrow as the delay between the last irradiation and injection was allowed to increase. After sixteen to thirty-two days, the inhibitory effect was essentially lost.

It is further suggested that the time required for the injected marrow to exert its inhibitory action, though unknown, is probably a matter of minutes or a few hours rather than of many hours or days.

Of additional interest is the difference which was revealed in tumor susceptibility of the sexes under conditions of this experiment. Females developed more tumors than males at all delay intervals studied; they therefore require earlier marrow injection than males, the difference being about 1.37 steps, each step denoting a doubling of the delay.

Protection of Mice Against X Irradiation by Plasma Proteins. Agnes N. Stroud, Austin M. Brues, and Mildred M. Summers. *J. Nat. Cancer Inst.* **15**: 1109-1124, February 1955.

Intravenous administration of serum or plasma, homologous or heterologous, or of plasma proteins to mice a few minutes before irradiation affords partial protection against death and other radiation effects. No protection against cataracts is apparent, but the survival pattern and pathologic changes of protected animals correspond in other respects to those of animals given lower radiation dosage. It has not been possible to reduce mortality after a dose of 800 r below that of unprotected mice given 550 r.

Two photographs.

Irradiation Protection through Removal of Cell Toxins with Kollidon (Polyvinylpyrrolidone). Hans Burger and Karl Peters. *Acta radiol.* **43**: 256-264, March 1955.

Irradiation produces characteristic cell damage

which has been attributed in part to toxic substances immediately forming in the karyoplasm. This toxic influence probably inactivates enzymes and is responsible for the disturbance in cell function manifested morphologically by chromosomal changes. As irradiation produces generalized effects on the organism, it is probable that toxic products also enter the blood stream.

The authors directed their research toward the amelioration and/or elimination of these toxic effects. Since the colloidal constituent of "Periston N," so-called "Kollidon" (Polyvinylpyrrolidone) attaches to pharmacological poisons and toxins and is eliminated through the kidneys, this substance was used to discover whether the detoxifying effect was generated in the cells or was extracellular. Previously one of the authors had shown, in experiments on rats, that Kollidon is instrumental in eliminating toxins through the kidneys and that it therefore decreases mortality in irradiated rats.

The germinating roots of *Vicia faba equina* were subjected to irradiation and subsequently Kollidon was applied. The mitoses after this treatment became normal and the pathologic anaphases and telephases were reduced, with fewer paranuclei. The authors explain these results by the fact that the Kollidon apparently acts within the cell itself, becomes attached to the cell toxin produced by irradiation, carries it away from the cell, and is washed out through the kidneys.

It is possible that these investigations will lead toward a discovery of great practical value which could be used during the course of roentgen therapy.

Six graphs.

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Baltimore, Md.



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